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(6) TEXTBOOK.

A SELF-TUTORING COURSE FOR ON-SITE TRAINING IN
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(8) NA
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BEDFORD, MASSACHUSETTS

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These materials have been approved for interim field use by the Air Defense Command. The purpose is to further implement the on-site training of AN/FST-2 maintenance technicians. In this regard, they are to be treated in accordance with official Air Defense Command policy regarding training materials. Their specific use is to be governed by the instructions which are delineated in the Course Monitor's manual.

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LESSON 1

In this lesson you should learn:

1. To identify the purpose of this course.
2. To use these lesson materials properly.

LESSON 1

Each of the lessons in this course starts out with a page which identifies the purpose of the lesson, like the one that you have just read. When you start each lesson you should read the introductory page carefully. If you know why you are reading the lesson, you will be better able to decide what parts of the lesson are most important to remember.

For some technicians this will be a review course because it deals with troubleshooting the Fine Grain Data Section of the AN/FST-2. The primary purpose of this course is to teach you to carry out the initial steps of Fine Grain Data Section troubleshooting in the most efficient manner. This course will be concerned with all of the troubleshooting activities that must go on before you turn to the oscilloscope and begin troubleshooting within the cabinets of the Fine Grain Data Section. This is called Phase I troubleshooting.

Within each of the lessons in this course you will find several participation exercises like the one on the next page. Each of these participation exercises will be set off by a line which is drawn around the exercise. The purpose of these exercises is to help you learn the material that you have been reading about just before the exercise. When you come to one of these exercises in the book, do the exercise immediately, and do your very best to answer any question correctly.

Now do the exercise below and then follow the instructions at the end of the exercise which tell you to turn to your ANSWER book.

Write your answer to this question in the space below the question. What is the purpose of this course?

Now turn to Page 1 in your ANSWER book.

This textbook is arranged so that you can do most of the work without any help from an instructor. In this lesson you are learning how to use the textbook properly. You have just learned how to use the cover sheet for each lesson and how to do the participation exercises.

In this textbook, LESSONS 2, 3, 4, 5, and 6 will teach you some useful general facts about troubleshooting complex electronic equipment. In these lessons you will also learn about a <u>strategy</u> for troubleshooting which you can use with almost any complex electronic equipment. After you have finished these lessons you will go on to the last four lessons in the textbook. These four lessons will teach you how to apply the troubleshooting strategy to the beginning steps in troubleshooting the Fine Grain Data Section of the AN/FST-2.

You should not attempt to do all of the lessons in this course in one day. You may, if you wish, do one, two, or three lessons a day; but you should never attempt to do more than three lessons in one day. You may wait one day or several days between lessons. Whether you wait only one day or whether you wait several, however, you should always briefly review the last lesson you studied before starting a new one. Further, you should review any lesson that you have already studied at any time you feel you would like to do so. In between lessons, you should attempt to apply what you have learned when you are working on the job.

At the end of each lesson, there is a test. These tests are different from participation exercises. You will know when you are taking a test because each test is labeled. Thus, the following test is

labeled Test A. The purpose of these tests is to find out whether or not you are ready to go on to the next lesson. You should take each of these tests without looking back at the material in the textbook. Then you should turn to the ANSWER book and score your own tests. You will find instructions in the ANSWER book telling you how to score your tests. If you answer every question in a test correctly, then you will know that you are certainly ready to go on to the next lesson. If you answer any test question incorrectly, you will find instructions in the ANSWER book telling you what to do to get ready to go on to the next lesson. Sometimes you will be told to review some of the material in the textbook if you miss a test question. Other times when you miss a test question, you will be told to consult with the Course Monitor. If you follow the instructions carefully, you will find that by the end of the course you will easily be able to pass the troubleshooting test that will be given by the Course Monitor.

Turn to Test A on the next page.

TEST A

Question 1

What is the purpose of this course? (Write your answer in the space below).

Turn to Page 2 in your ANSWER book and score your own answer.

Question 2

How quickly should you do the lessons in this textbook?

Turn to Page 3 in your ANSWER book for the correct answer.

LESSON 2

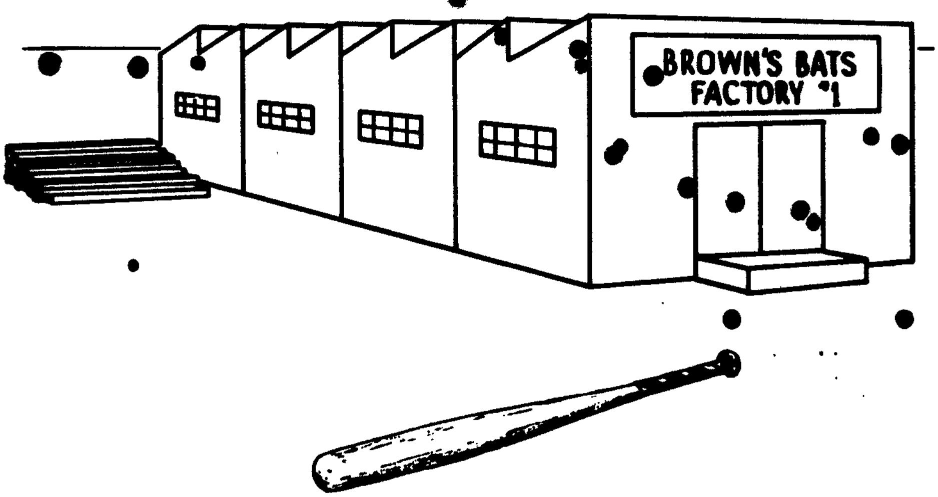
In this lesson you should learn:

1. To interpret a ▭, a ○, and an ⟶ when they are used in a troubleshooting diagram of a system.
2. To draw a diagram of a simple system using boxes, circles, and arrows.

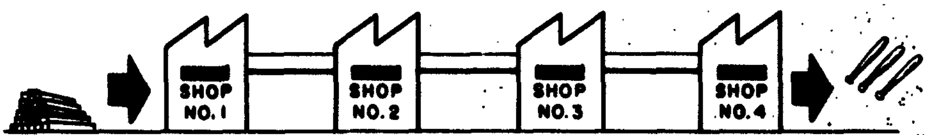
LESSON 2

In order to talk about troubleshooting without using an actual piece of equipment for demonstration, we need a way to describe complex equipment like the T-2 in schematic form on paper. Therefore, before beginning the refresher training about troubleshooting, let us review a method by which systems like the T-2 can be described schematically in a way that is very useful for troubleshooting purposes.

Let us start out by talking about a very simple kind of system with which you are likely to be familiar and which involves no electronics at all. Let us assume that our system is a factory which produces baseball bats. This factory uses unfinished lumber as raw material. That is, the input to this system is unfinished pieces of wood of various sizes. The output is finished baseball bats. We could picture this system as shown here.



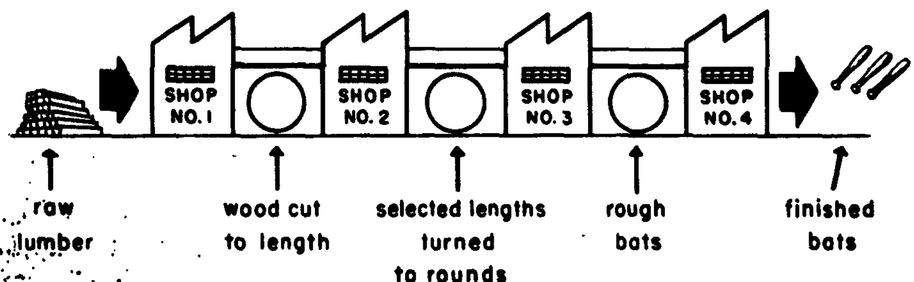
Now let us further assume that this factory is really made up of a series of shops which are connected by hallways as shown in the figure below.



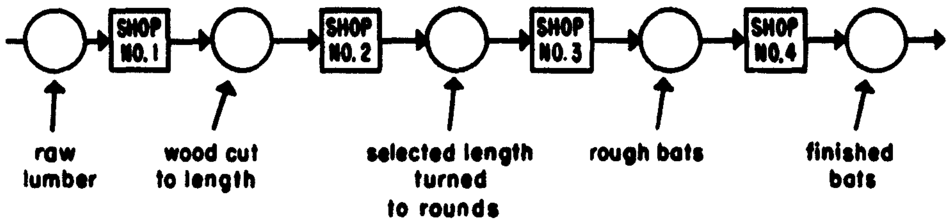
In this arrangement each shop accomplishes one of the functions or manufacturing operations necessary to change the raw lumber into the final product. These shops are so arranged that when the first process is finished the material is passed on through the hallway to the next shop where the next manufacturing operation takes place and so on in a series arrangement until the finished product comes out at the end.

In this arrangement of shops and hallways a specific manufacturing function is accomplished in one shop, and when the process has been applied to a piece of material it is passed through the hallway to the next shop. Thus, no processing is accomplished in the hallway; the material is simply passed on through the hall to the next shop. You can see with this arrangement that if the first shop in the sequence turns out faulty materials or fails to turn out materials at the proper rate, every other subsequent shop will be affected. Now suppose we want to monitor the manufacturing process to determine whether or not everything is going well. We could do this by keeping track of the final output of the last shop in the line, and so long as baseball bats of good quality come out of the last shop at the proper rate, we would know that the whole system were operating properly. However, if we observe that the final output is bad, then we must have some way of locating the source of trouble. In this system a good

way to provide for locating the source of trouble would be to provide windows or inspection points at each of the hallways. The hallways would be a good place to look because the materials will not be undergoing processing in the hallways and it will therefore be relatively easy to describe what the materials should look like at those points. In the figure below we have added these windows or inspection points by drawing a circular window at each hallway.



If we can define what the materials should look like at each of these inspection points, we will be able to troubleshoot this manufacturing system without being concerned about what takes place in each of the shops because we are able to tell from the inspection points what is going into each shop and what is coming out. It is obvious that this arrangement of shops and inspection points makes it quite simple to tell which shop is malfunctioning. However, it is a lot of bother to draw a picture with as much detail as the one shown above. It is simpler to use plain boxes to stand for the subsystems or functions, and to use plain circles to stand for the inspection points or indicators, and to use lines and arrows to show the flow from one subsystem to the next. Thus we can very easily describe this manufacturing system with boxes, circles, lines, and arrows as we have done in the figure shown on the next page.



In this training session we will describe electronic systems using boxes, circles, lines, and arrows in the same way that they have been used to describe the baseball bat manufacturing system. Circles will be used to represent instruments that are used to read-out or inspect the operation of the system at the places where the circles are put in the diagram. For example, in describing the T-2, we will use <u>circles</u> to indicate the places where we can use the PPI, RAPPI, or a meter to inspect the signal which flows between two functions. You should note that a circle is used not only to stand for an instrument which displays the signal between two subsystems, but also to identify the <u>place</u> at which an instrument is inserted in order to inspect the signal.

(a) What does ○ stand for in a system diagram?

(b) What can you tell from the <u>location</u> of a circle in a diagram?

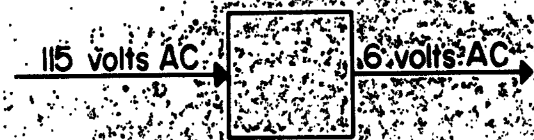
Turn to Page 4 in your ANSWER book.

We will use boxes in these lessons to identify subsystems which carry out some necessary function within the T-2. For example, we will use a box to stand for a Quantizer function, and a box to stand for a Register function. It is important to know that the boxes in this sort of diagram do not stand for a particular piece of equipment in a particular cabinet or on a particular chassis. The boxes stand for functions which are carried out by equipment. When we troubleshoot using this kind of diagram, we try to find out what function is wrong. By a function we mean something which must happen in the system to make it operate properly. After we locate the bad function, we can ask what equipment is responsible for that function, and we will be able to locate and repair the bad equipment. It is important to know, however, that the equipment which carries out a function defined by a box may not be contained within one cabinet or in one package. Thus, boxes do not always correspond to hardware packages, but they do always represent a function. Remember, in this kind of diagram, boxes stand for functions, and when you use this kind of diagram, you are trying to find what function in the operating equipment is BAD. You will not have to worry about identifying the hardware that carries out the function until after you know which function is BAD.

What does a ▭ stand for in a system diagram?

Turn to Page 5 in your ANSWER book.

Suppose you have been troubleshooting a radio, and that you have isolated the trouble to the function described by the box below. The correct inputs and outputs are shown in the diagram.



(a) What is the name of the hardware you would replace?

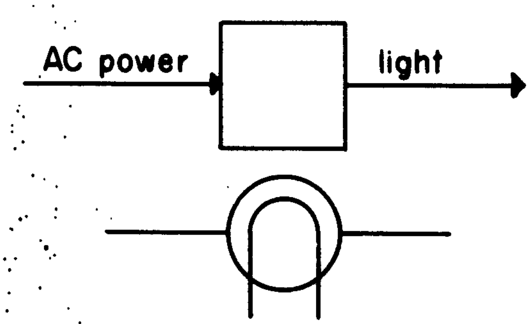
(b) What kind of function does the box describe? Is it a resistance function, an amplifier function, or a voltage reduction function?

Turn to Page 8 in your ANSWER book.

(a) Can you describe the function of an automobile generator by a box?

(b) What does this symbol stand for?

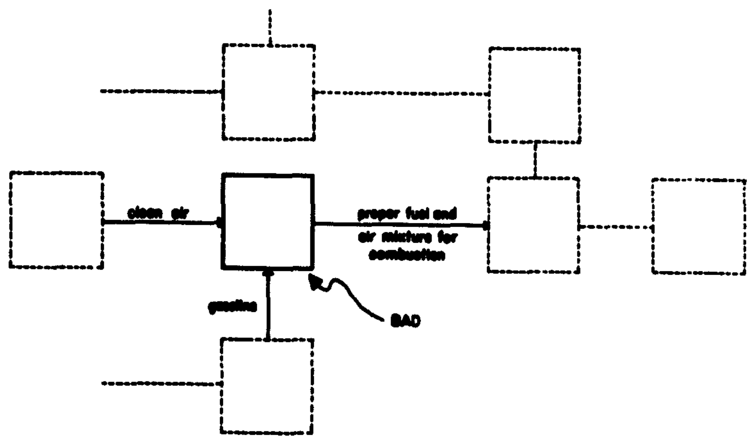
(c) What is the difference between the meaning of these two symbols?



Turn to Page 7 in your ANSWER book.

Your automobile will not run smoothly, and you have decided to find the cause and fix it. To help you with your troubleshooting, you have a diagram which describes the automobile in terms of the functions that go on when it is operating properly. Using this diagram, you have run through a troubleshooting procedure. As the result of that procedure, you have guessed that the function shown below is BAD.

(a) Describe in your own words the bad function (the function that is described by Box A below).



(b) Can you tell the name of the hardware or part that carries out the function described by the box?

(c) If you were sure that the function carried out by Box A were BAD, what would you do?

Turn to Page (8) in your ANSWER book.

You can see that a typical schematic diagram of a system which used symbols like this    is intended to describe the hardware in the system, and that such a diagram can be used to describe a system sitting on a shelf. On the other hand, a diagram in terms of circles and boxes is used to describe the way a system operates by identifying the functions that take place within the system when it is operating properly.

When you describe the way a system operates using boxes for functions and circles to indicate read-outs, you must also tell how the functions are related to each other. That is, you must tell which functions occur first, which occur later, and which functions feed information or power to other functions. The relationships among functions are described by arrows which connect related boxes. Thus, arrows are used to show the direction in which an output is going, or in other words, the direction of the data flow. The arrows do not stand for cables or wires because a functional description of a system in terms of boxes is not a description of the hardware. A functional description tells what takes place in the operating system.

Because circles stand for read-outs, and because read-outs are always placed on the arrows which connect boxes, it is necessary in a troubleshooting diagram to label all of the arrows so that you know what information you are reading out when you use an indicator that is on an arrow.

> Look at Diagram 7-1 in your DIAGRAM book now. This is an example of a troubleshooting diagram of a system (part of the AN/FST-2) which is drawn using circles, boxes, and arrows.

The method of describing a system, such as that shown in Diagram 7-1, looks like a "block diagram". It is really different from a block diagram, however. In a troubleshooting diagram like Diagram 7-1, it is not necessary to label the boxes as in a block diagram; but it is

essential to label the signals or arrows which connect the functions. Thus, in the troubleshooting description, we identify functions or subsystems in terms of the input or output signals which connect them as shown by the arrows. In a block diagram, the inputs and outputs are usually not labeled; only the boxes are labeled.

Why are arrows ⟶ used in troubleshooting diagrams?

Turn to Page 8 in your ANSWER book.

TEST B

Question 1

What does a ▭ represent in a system diagram?

Turn to Page 10 in the ANSWER book and score your own answer.

Question 2

What does a ○ represent in a system diagram?

Turn to Page 11 in the ANSWER book and score your own answer.

Question 3

An arrow in a system diagram stands for ________

____

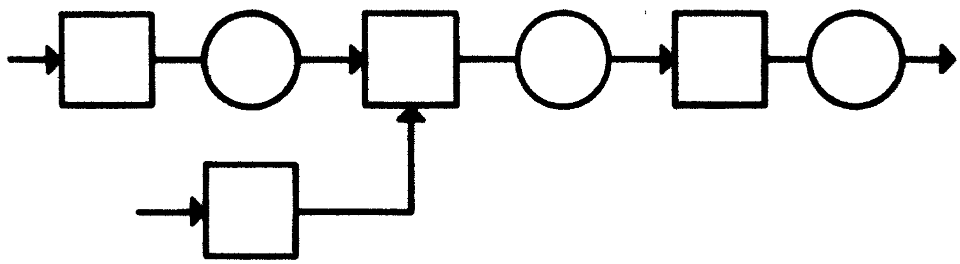
____

Turn to Page 12 in the ANSWER book and score your own answer.

TEST B

<u>Question 4</u>

Identify all of the subsystems in the system below by numbering them.

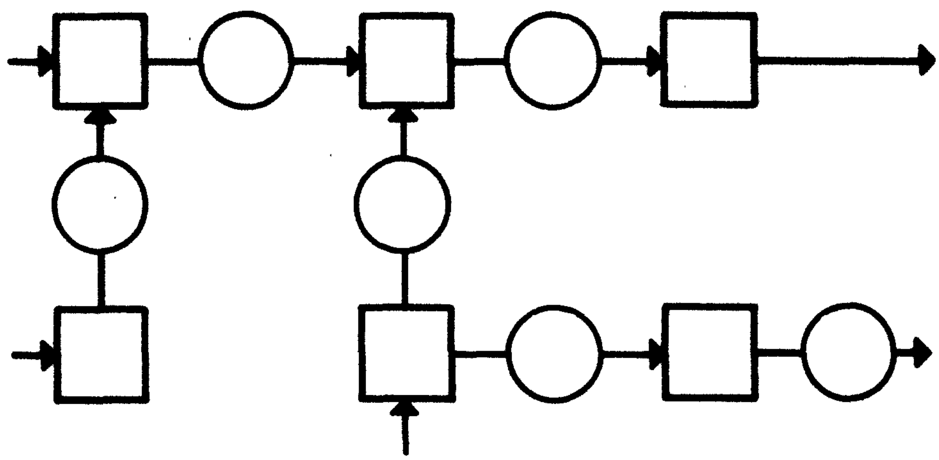


Turn to Page [illegible] in the ANSWER book and score your own answer.

TEST B

Question 5

Identify all of the inspection points in the system below by placing a letter at each one.



Turn to Page 14 in the ANSWER book and score your own answer.

TEST B

Question 6

Using only boxes, circles, and arrows, draw a diagram for a system with a single system input; two subsystems; and two indicators, one for each subsystem output; and a single system output.

Turn to Page [illegible] in the ANSWER book and score your own answer.

TEST B

<u>Question 7</u>

Using only boxes, circles, and arrows draw a diagram for an <u>imaginary</u> system which has:

(a) A video input to a video data quantizer.

(b) Provision for a PPI display of the quantizer output (shaped video) which goes to a video mapper.

(c) A mapped video output from the video mapper which can be displayed on a PPI-2.

(d) LABEL the figure you draw completely.

Turn to Page 16 in the ANSWER book and score your own answer.

LESSON 3

In this lesson you will learn:

1. How to define three phases of trouble-shooting in terms of where each phase starts and stops.
2. A troubleshooting strategy which you will be able to apply to find a malfunction in any phase of troubleshooting.
3. How to apply the troubleshooting strategy to a troubleshooting diagram composed of the symbols you learned about in the last lesson.

LESSON 3

This course has to do with corrective maintenance. That is, it has to do with troubleshooting the Fine Grain Data Section of the T-2 when this section fails during normal operation. Troubleshooting the Fine Grain Data Section starts when there is evidence of a malfunction in an operational channel. For example, troubleshooting might be initiated by a call from the DC reporting that the information being received appears to be wrong or garbled. Again, the need for troubleshooting might be indicated by the sounding of a warning bell. Whatever signal starts the troubleshooting, it will be an indication that corrective repair is required in the Fine Grain Data Section in order to return the channel containing the malfunction to an operational status as soon as possible.

Once it has been started by such a signal, troubleshooting of the Fine Grain Data Section must continue until the source of the trouble is located and the malfunctioning component is replaced with a good component. Frequently in the case of the AN/FST-2 this will mean replacing a bad logic card with a good one. Troubleshooting of the Fine Grain Data Section itself is ended when the bad component has been replaced by a good one and the system is once again in operation.

The above description of AN/FST-2 troubleshooting is typical of the way troubleshooting starts and ends for almost any complex electronic equipment. For any equipment, troubleshooting is initiated by a signal which indicates that corrective repair or adjustment of the system is required. That signal may or may not contain information which will help identify the source of the trouble; but it will tell you, at the very least, that something has gone wrong with the system.

The purpose of the troubleshooting process which is initiated by such a signal is to find the malfunction in the system so that the system can be repaired quickly and put back on-the-air. Troubleshooting, then, is everything which happens between the initial information that something is wrong with the system and the location of the repairable or replaceable or adjustable component which has caused the original signal.

Fill in the blanks in the paragraph below by selecting the correct word for each blank from the list of words under the paragraph.

The signal which starts ____________ of the Fine Grain Data Section will be any indication that something is ____________ in the equipment. The ___________ might be a call from the DC saying only that the output message is garbled. Thus, the signal which starts troubleshooting may _____ give you any clue as to what is wrong with the system. Once the troubleshooting process is started by such a signal, it must continue until the replaceable or adjustable ____________ that is ______ has been located. Then the system must be "fixed" and put back ____________.

troubleshooting	signal	not
component	malfunctioning	
on-the-air	BAD	

Turn to Page (17) in your ANSWER book.

For any system, the beginning of troubleshooting is always a simple indication that something has gone wrong. The end of the troubleshoot-

ing process is another matter because, in any system with a large number of replaceable components, there are a large number of possible answers to any troubleshooting problem. Somehow, in the troubleshooting process, you must go from a simple indication that there is a malfunction to the precise identification of the one component that is causing the trouble. That one may be any one of 100,000 components in a large system.

Once started, troubleshooting must continue until the replaceable component that is BAD has been identified so that it can be replaced or repaired. The goal of the corrective maintenance procedure is to put the system back on-the-air. If the system contains 100,000 replaceable components, there are 100,000 possible answers to the troubleshooting question. This large number of answers creates a difficult problem for the troubleshooter who must find which one of 100,000 possible answers is the correct one. That is, he must locate that one of 100,000 replaceable components that contains the malfunction.

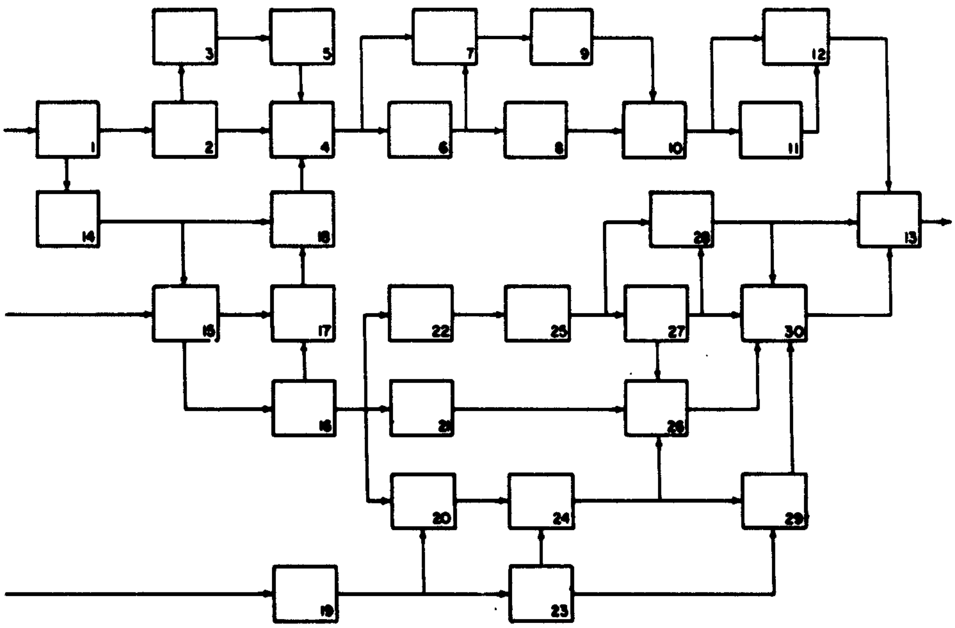
Fill in the blanks in the paragraph below by selecting the correct word for each blank from the list of words under the paragraph.

Troubleshooting of any system may be initiated by a simple __________ that something has gone __________. Although the __________ of the troubleshooting process is simple, the end point may be __________. Thus, the end point is not a simple bit of information, but rather it is one __________ answer out of a very large number of __________ answers. In a system of 20,000 replaceable components, there are __________ possible answers to a troubleshooting problem. The goal of troubleshooting such a system is to find the __________ correct answer out of 20,000 possible answers.

complex	start	one	possible
signal	correct	20,000	wrong

Turn to Page 18 in your ANSWER book.

Since there are so many possible answers to a troubleshooting problem in a complex system, we need some way to make the problem simpler. One way to avoid having to choose from among a large number of possible different answers is to cut the problem down to size by arbitrarily splitting up the entire system into a relatively small number of functions at the start. For example, we might start out by splitting up a system of 27,000 replaceable components into only 30 functions as shown in the diagram below.



When we do this, each function will contain an average of 900 replaceable components.

Thus:

There are 27,000 components sorted into 30 boxes.

$$30\overline{)27,000 \text{ components}}^{\;900 \text{ components per box}}$$

Or:

$$\begin{array}{r} 900 \text{ components} \\ \underline{\times\ 30 \text{ boxes}} \\ 27{,}000 \text{ total components} \end{array}$$

If we do this, then the initial troubleshooting task is simply to identify which one of the 30 different functional units (boxes) contains the malfunction. Thus, instead of having to decide which of 27,000 different possible answers is correct, we need to consider only 30 possible answers at first. We might call this Phase I troubleshooting. At the end of Phase I troubleshooting, we should be able to say which of the 30 different boxes contains the malfunction.

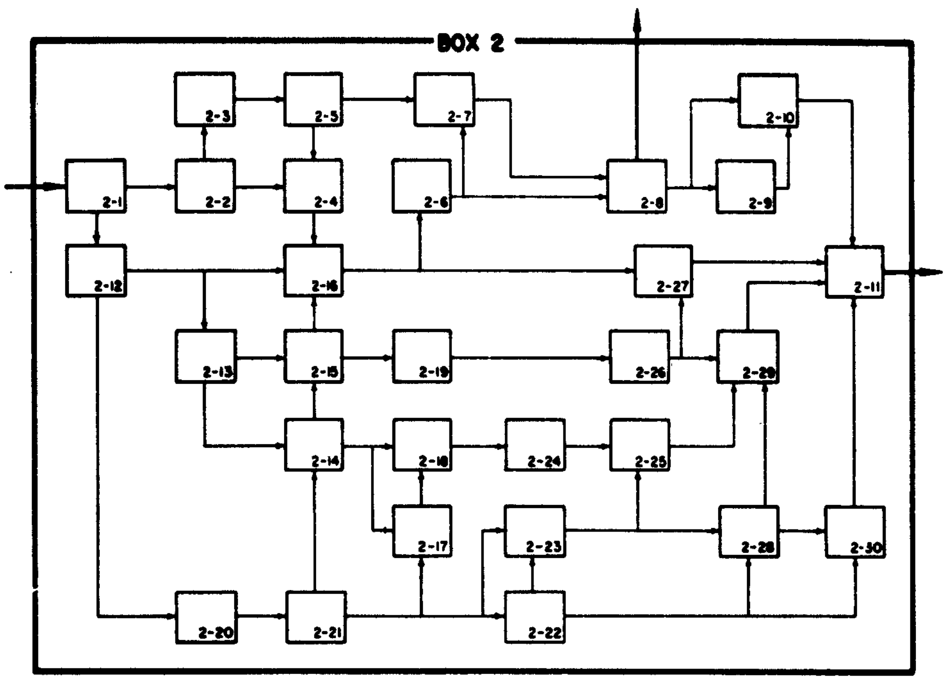
Fill in the blanks in the paragraph below by selecting the correct word for each blank from the list of words under the paragraph.

For a system with 30 functional units, ________ troubleshooting is initiated by the simple signal that starts the troubleshooting process. Phase I troubleshooting ends with the identification of the correct one out of ________ functional units or "boxes" that contains the ________. When you have ________ the one box (out of 30) which contains the malfunction, you will not know what ________ to replace, however, because that box will contain a ________ number of replaceable components itself. Therefore, the troubleshooting process is not over when you reach the ________ of Phase I. At the end of Phase I, you have simply narrowed down the area which contains the malfunction to ________ of the system.

Phase I	end	located	30
malfunction	large	component	1/30th

Turn to Page 10 in your ANSWER book.

Suppose we were to carry out Phase I troubleshooting on the system in the diagram on Page 3-5 and suppose we were to find that the malfunction is located in Box 2. Then we could confine our interest to Box 2 and ask: "Which of the 900 components in Box 2 is BAD?" However, even 900 possible answers is a large number, so to make it easier we might set up Phase II troubleshooting just like Phase I. Thus, we might draw a diagram <u>just for Box 2</u> which breaks into 30 functions like this:



Then we could again ask: "Which of the 30 boxes contains the malfunction?" In this case, each box in the diagram above would contain 30 repairable components on the average because:

$$\begin{array}{rl} & 30 \text{ boxes} \\ \times & 30 \text{ components} \\ \hline & 900 \text{ repairable components} \end{array}$$

If the answer to Phase II troubleshooting were Box 2-17, for example, then we could go on to Phase III and do the same thing once more. At the end of Phase III, we would be down to the repairable components. Thus, if the answer to Phase III troubleshooting tells which one of the 30 components in Box 2-17 is BAD, we would have found the one box out

of 27, 000 which caused the trouble.

Notice that by dividing the total troubleshooting process into three phases, we never have to consider more than 30 possible answers at a time, even though the system contains 27, 000 repairable components.

This approach of cutting the total troubleshooting problem up into phases so that within each phase there is a relatively small number of possible answers to the troubleshooting question is a very effective way to troubleshoot. You can use this approach with any complex system for any phase of troubleshooting, and it is the troubleshooting approach which you will learn to use in this course.

> Suppose you want to set up a troubleshooting procedure for a system with 600 replaceable parts, and suppose further that you wish to use only two phases in the troubleshooting procedure. For Phase I, you might divide the system into 20 functional units or boxes.
>
> (a) If you did this, how many replaceable parts would be included in each box (on the average)?
>
> (b) If you partition the total system into 20 functional units for Phase I, how many possible answers would there be for each Phase II troubleshooting question (on the average)?

Turn to Page 28 in your ANSWER book.

The troubleshooting process for almost any complex electronic system can be divided into phases in the manner that has just been described. Thus, for almost any system it is possible to describe a number of troubleshooting phases such that the troubleshooter never has to consider more than 20 to 30 possible answers at one time.

In this course you will learn how to carry out Phase I troubleshooting of the Fine Grain Data Section of the AN/FST-2. The troubleshooting principles you will learn can, of course, be applied to Phase II and Phase III troubleshooting of the Fine Grain Data Section, if you want to attempt to do that yourself. However, you will not be taught in this course how to do Phase II or Phase III troubleshooting. This course is focused on Phase I simply because doing Phase I correctly is most important when it comes to saving troubleshooting time. If you carry out Phase I troubleshooting of the Fine Grain Data Section properly and quickly, you will always be working in the right functional area of the system when you carry out Phases II and III.

Phase I troubleshooting of the Fine Grain Data Section starts when you receive any signal which means that a failure has occurred in one of the channels.

Phase I troubleshooting ends when you have identified the functional area of the Fine Grain Data Section which actually contains the malfunction. In Phase I troubleshooting of this equipment, there are 28 possible functional areas which might contain the malfunction; therefore, there are only 28 possible answers to any Phase I troubleshooting problem. The Phase I troubleshooting procedure that has been worked out for the Fine Grain Data Section does not include use of the oscilloscope for troubleshooting. The troubleshooting process includes only the use of the Warning Lights, the various PPI positions, and the RAPPI as indicators.

As you learned earlier in this lesson, the purpose of Phase I troubleshooting is to identify the functional area which contains the malfunction so that Phase II troubleshooting can be confined to that area. In troubleshooting the Fine Grain Data Section, Phase II troubleshooting

starts with the use of the oscilloscope and ends with the identification of the bad logic card which has caused the system to malfunction. Therefore, another way to look at Phase I troubleshooting of the Fine Grain Data Section is to say that the objective is to localize the trouble to the correct functional area so that Phase II troubleshooting with the oscilloscope can be started in the right place and can be carried out efficiently.

If you were to ignore Phase I troubleshooting and immediately start using the oscilloscope at the first indication of a malfunction in the Fine Grain Data Section, you would probably waste a lot of time searching around, because there are many places where you can start to probe with the oscilloscope. By first performing Phase I troubleshooting, you will be able to narrow down the start of Phase II troubleshooting to a small functional area and thus save a lot of time.

> Fill in the blanks in the paragraph below by selecting the correct word for each blank from the list of words under the paragraph.
>
> Phase I troubleshooting of the Fine Grain Data Section starts when there is any indication of a __________ in an __________ channel. The purpose of Phase I troubleshooting is to __________ down the __________ of a malfunction to a small __________ area. This will make it easy to decide where to plug in the __________ and start __________ troubleshooting.
>
> | | | |
> |---|---|---|
> | narrow | malfunction | oscilloscope |
> | Phase II | functional | operating |
> | location | | |

Turn to Page 21 in your ANSWER book.

Now you know how to identify Phase I troubleshooting for the Fine Grain Data Section in terms of where it starts and where it stops. The next thing we must consider is <u>how</u> you go from the beginning of Phase I troubleshooting to the end. What is the method that you must use to find the correct answer (out of 28 possible answers) for any Phase I troubleshooting problem? The method that you will learn to use can be called a <u>strategy</u>. It can be called a strategy because it is a very general approach which can be used for <u>any</u> Phase I troubleshooting problem. The strategy is quite simple; it consists of three steps:

1. GATHER
2. GUESS
3. CHECK.

These three steps in the troubleshooting strategy are initiated by a signal that there is a malfunction in the system. To carry out the GATHER step, read-out information is gathered from certain indicators which display information about the way the system is operating. Next, the GUESS step is performed. To carry out the GUESS step, all of the gathered information must be considered, and, a GUESS must be made which identifies the functional area or box in the system which contains the malfunction. Ordinarily, in any system there will be no more than 20 or 30 possible answers or GUESSES that can be made; in the Fine Grain Data Section, there are 28 possible GUESSES. Then, to make sure that the Guess has been a correct one, the CHECK step must be carried out. The purpose of the CHECK step is to insure that the GUESS is a correct one, so that Phase II troubleshooting will be started in the right functional area of the system.

Turn to the exercise on the next page.

1. You have just learned that you can use a strategy to get from the beginning of Phase I troubleshooting to the end of Phase I troubleshooting.

   (a) When do you use that strategy for Phase I troubleshooting?

   (b) What are the names of the steps in that strategy?

   (c) What is the order in which you must use these steps?

2. (a) What do you GATHER when you carry out the GATHER step?

   (b) What do you GUESS when you carry out the GUESS step?

   (c) What is the purpose of the CHECK step?

Turn to Page 22 in your ANSWER book.

Now let us consider what information you need in order to carry out the three steps of the troubleshooting strategy for Phase I troubleshooting. First, of course, you need to be able to tell when the system is malfunctioning, so that you know when to start troubleshooting. Then, in order to carry out the first step, the GATHER step, you need to know what information to GATHER. That is, you need to know what indicators to read in order to GATHER all of the information that you will need to make a GUESS about the location of the malfunction. Although you might be able to work out a list of the proper indicators for any complex system that you might have to troubleshoot, it is usually not easy to decide which indicators to use. Therefore, the best way to provide for the GATHER step is for experts to prepare a list of the indicators from which you must GATHER information every time you start Phase I troubleshooting. In this course, which has to do with Phase I troubleshooting for the Fine Grain Data Section, you will be given a prepared list of the indicators that you must read in order to carry out the GATHER step; and you will be able to carry that list with you on the job when you have to perform Phase I troubleshooting.

In order to carry out the second step in the strategy, the GUESS step, you need to know what GUESSES are possible. Again, you might be able to work this out for yourself; but, it is easier to provide you with a list of all of the possible GUESSES that you could make in Phase I troubleshooting. In the case of the Fine Grain Data Section, it turns out that there are 28 possible GUESSES that you can make. Each of these 28 GUESSES is a different functional area of the Fine Grain Data Section, and taken together, all 28 of these functional areas cover the whole of the Fine Grain Data Section. Before you finish this course, you will be given a list of all of the functional areas to which you can isolate a trouble during Phase I troubleshooting of the Fine Grain Data Section; and you will be able to carry this list with you when you do Phase I troubleshooting on the job. Therefore, you will not have to memorize the 28 possible answers for Phase I troubleshooting.

A list of the indicators which you must read to GATHER information

and a list of the possible GUESSES that you can make about the location of the malfunction, is not enough, however. You also need some rules and principles for using the information that you GATHER in order to make a GUESS. In LESSON 5, you will begin to learn some of the rules that you can use for making good GUESSES about the location of the malfunction on the basis of information that you GATHER. The rules that you will learn will be useful in troubleshooting any complex electronic equipment; but, they will be especially useful in GUESSING the location of a malfunction during Phase I troubleshooting of the AN/FST-2. You must commit these rules and principles for GUESSING to memory because they will be used in so many different ways from one troubleshooting problem to another that it is not possible to write down on a small sheet of paper all of the ways in which they can be used. You must learn the rules and use your ingenuity in applying them when you carry out Phase I troubleshooting. However, you will find out that in order to use these rules, it will be useful to have a description of the way in which the 28 functional units of the Fine Grain Data Section operate together when the system is functioning normally. Therefore, you will be given a diagram which describes the way the Fine Grain Data Section works, and you will be able to use this diagram on the job when you carry out Phase I troubleshooting.

The diagram that you will be given will look something like Diagram 7-1 in your DIAGRAM book.

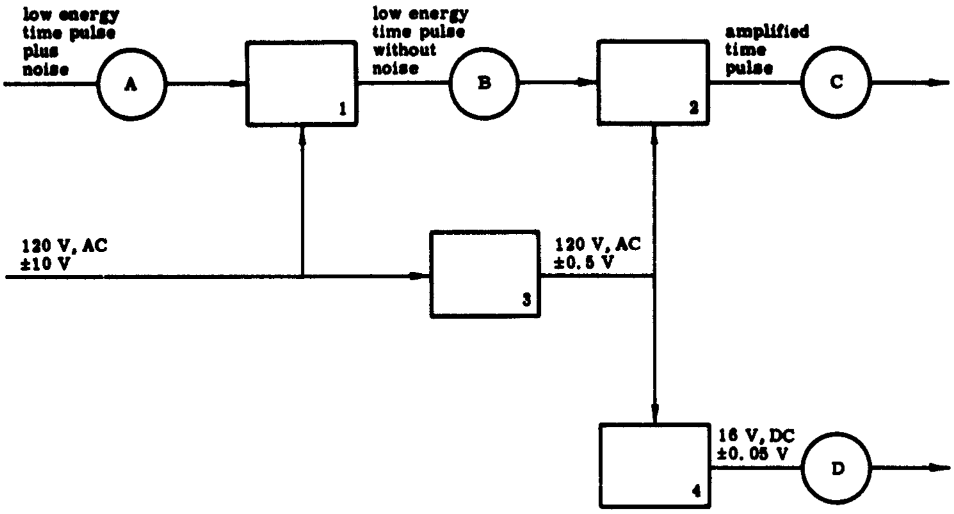
Open the DIAGRAM book to Diagram 7-1 now.

Now you will understand why you were taught in LESSON 2 to read a troubleshooting diagram. Diagram 7-1 is made up of circles, boxes, and arrows, as you can see. In a troubleshooting diagram like this, the circles identify all of the indicators from which you must GATHER information to carry out the first step in the troubleshooting strategy. The boxes identify all of the possible answers for Phase I troubleshooting, and therefore, any GUESS that you make must be one of the boxes

shown in the diagram. Thus, the boxes provide you with a list of all of the possible answers. The circles and boxes are not merely listed in the diagram; rather, the way in which the boxes or functions interact during the operation of the system are shown by arrows which connect the boxes. These arrows show the data flow among the functions which are carried out when the system is operating normally. Further, the circles are placed on the arrows to show <u>where</u> the information is read out. In LESSON 5 you will begin to learn how you can use a diagram of this kind to help you make your GUESSES about the location of malfunctions during Phase I troubleshooting. Without a diagram of this kind, which has been prepared beforehand, it would be difficult to carry out Phase I troubleshooting. Without it, you would not know what indicators to use to GATHER information; you would not know what functions would be possible answers for the Phase I troubleshooting problem; and you would not know how the functions were related to each other.

You will not learn any more about the CHECK step until you come to LESSON 6. Later you will be given job aid materials that you can use on the job to help you carry out the CHECK steps that you will learn about in this course.

Turn to the exercise on the next page.



The diagram above is a very simple Phase I troubleshooting diagram for an imaginary system.

(a) What symbols in the diagram will help you carry out the GATHER step?

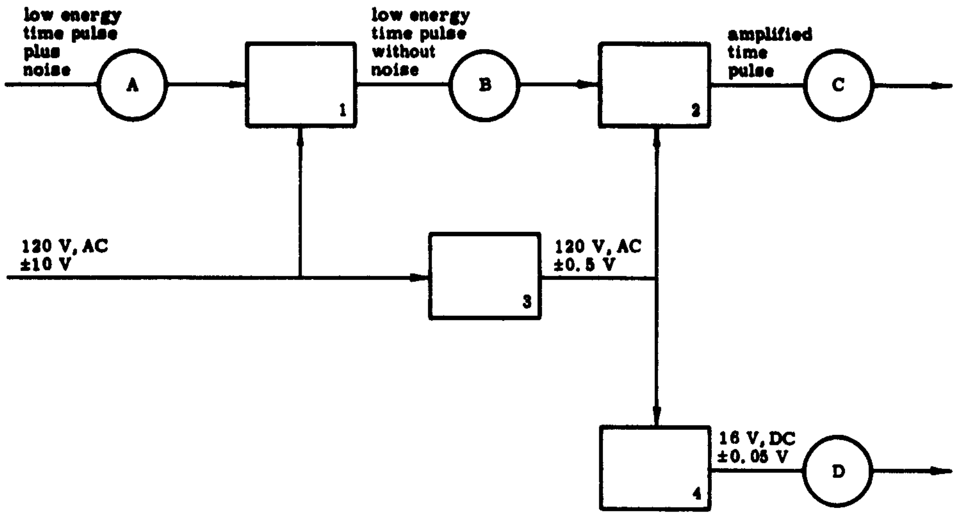
(b) Suppose there are 30 indicators built into this system, all of which could be used to read-out information about system operation. Would you be able to tell which four to GATHER information from for Phase I troubleshooting without a Phase I troubleshooting diagram like the one shown above?

Turn to Page 3-17 and continue the exercise.

shown in the diagram. Thus, the boxes provide you with a list of all of the possible answers. The circles and boxes are not merely listed in the diagram; rather, the way in which the boxes or functions interact during the operation of the system are shown by arrows which connect the boxes. These arrows show the data flow among the functions which are carried out when the system is operating normally. Further, the circles are placed on the arrows to show where the information is read out. In LESSON 5 you will begin to learn how you can use a diagram of this kind to help you make your GUESSES about the location of malfunctions during Phase I troubleshooting. Without a diagram of this kind, which has been prepared beforehand, it would be difficult to carry out Phase I troubleshooting. Without it, you would not know what indicators to use to GATHER information; you would not know what functions would be possible answers for the Phase I troubleshooting problem; and you would not know how the functions were related to each other.

You will not learn any more about the CHECK step until you come to LESSON 6. Later you will be given job aid materials that you can use on the job to help you carry out the CHECK steps that you will learn about in this course.

Turn to the exercise on the next page.



The diagram above is a very simple Phase I troubleshooting diagram for an imaginary system.

(a) What symbols in the diagram will help you carry out the GATHER step?

(b) Suppose there are 30 indicators built into this system, all of which could be used to read-out information about system operation. Would you be able to tell which four to GATHER information from for Phase I troubleshooting without a Phase I troubleshooting diagram like the one shown above?

Turn to Page 3-17 and continue the exercise.

(c) Why do you GATHER information about system operation as the first step in Phase I troubleshooting?

(d) What do the boxes in the diagram have to do with the GUESS step?

(e) Why not use a chart like the one shown below for Phase I troubleshooting instead of the diagram shown above?

GATHER from:	GUESS which one of these boxes contains the fault:
Indicator A	Box 1
Indicator B	Box 2
Indicator C	Box 3
Indicator D	Box 4

(f) What does the CHECK step have to do with Phase II troubleshooting?

Turn to Page 23 in your ANSWER book.

TEST C

Fill in the blanks in the paragraph below. Use either a word or a phase in each blank.

Question 1

This course will teach you to do ____________

____

which starts when ____________________________

____

and which ends with __________________________

____

Question 2

In order to do Phase I troubleshooting on the Fine Grain Data Section, you must use a ________ which has ____________ steps. These steps are called: ____

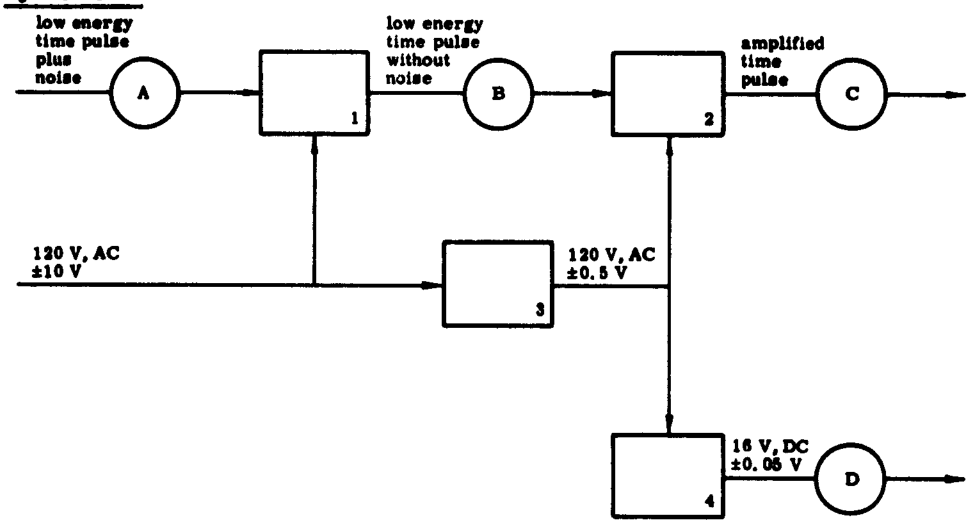
Question 3

At the end of Phase I troubleshooting you will know that the malfunction is in a specific _______ ________________ of the Fine Grain Data Section and you will be ready to start ________________ troubleshooting, using the ______________ to locate the malfunction more precisely.

Turn to Page 25 in your ANSWER book and score your own answers.

TEST C

Question 4



The diagram above is a very simple Phase I troubleshooting diagram for an imaginary system.

(a) What does the circle labeled A stand for?

(b) Does Box 1 stand for a function in the operating system?

(c) Is there some specific hardware which carries out the function of Box 1?

Turn to Page 3-21 and continue the test.

TEST C

(d) If Box 1 has a malfunction, will it be caused by a replaceable hardware component which carries out part of the function of Box 1?

(e) What information would you GATHER to start Phase I troubleshooting of this system? (Name the indicators that you would use.)

(f) What are all the possible GUESSES that could be given for a Phase I troubleshooting problem?

(g) In Phase I troubleshooting, you need a Phase I _________ ___________ which will tell you what indicators to use to ____________ information. The diagram will also tell you what GUESSES you can make because every ________ in the diagram is a possible GUESS. The arrows which show data flow will help you to make a ___________. When you have made a GUESS, you must _________ the GUESS before you go on to ___________ troubleshooting.

Turn to Page (26) in your ANSWER book and score your own answer.

LESSON 3A

YOU DO NOT HAVE TO STUDY THIS LESSON UNLESS YOU FAILED ANY PART OF QUESTION 4 IN TEST C

However you may wish to use it to review LESSONS 2 and 3 even if you answered all of Test C correctly.

The purpose of this lesson is to review all of the important facts which were covered in LESSON 2 and LESSON 3. If you study this lesson carefully, you will be able to answer all of the questions in Re-Test C at the end of LESSON 3A.

LESSON 3A

1. <u>What equipment will you be able to troubleshoot when you have finished this course?</u>

   At the end of this course you will be able to carry out Phase I troubleshooting for the Fine Grain Data Section of the AN/FST-2.

2. <u>When do you start Phase I troubleshooting?</u>

   You start Phase I troubleshooting whenever you receive a signal such as a call from the DC or an audible alarm which tells you there is a malfunction in an operating T-2.

3. <u>What can you say about the location of the malfunction at the end of Phase I troubleshooting?</u>

   At the end of Phase I troubleshooting you will be able to say that a malfunction in the Fine Grain Data Section is located in a specific functional area (box) within the operating Fine Grain Data Section.

4. <u>What is the reason for doing Phase I troubleshooting?</u>

   The reason for doing Phase I troubleshooting is to isolate a malfunction in the Fine Grain Data Section down to an area which is small enough so that you can begin to use the oscilloscope to pinpoint the malfunction. When you begin to use the oscilloscope, however, you will be doing Phase II troubleshooting.

5. Does this course teach you to do Phase II troubleshooting?

No. This course is designed to teach you to do Phase I troubleshooting. Therefore, this course does not include instruction in the use of the oscilloscope.

6. When do you use a strategy in Phase I troubleshooting?

As soon as you begin troubleshooting in response to a signal that there is malfunction in the T-2 you begin to use a strategy. Whenever you conduct Phase I troubleshooting you should always use a strategy. The strategy that you should use should always be the same one. It should be the three-step strategy which you will learn to use in this course.

7. What are the steps in the strategy which you will use?

The strategy that you will always use in carrying out Phase I troubleshooting is in three steps. You will always use the steps in the same order. The order of the steps is: (1) GATHER; (2) GUESS; and (3) CHECK.

8. What is the GATHER step?

In the GATHER step you will collect information about the way in which an operating channel is operating by using certain indicators that tell you about the operation of the Fine Grain Data Section.

9. What is the GUESS step?

In the GUESS step you will use the informationyou have gathered in the first step and make a guess about the location of the malfunction. Your guess will be a statement that the malfunction

is probably located in a special functional area or box of the operating Fine Grain Data Section.

10. What is the CHECK step?

The CHECK step is one in which you perform certain tests in order to prove that you have made a good GUESS about the location of the malfunction.

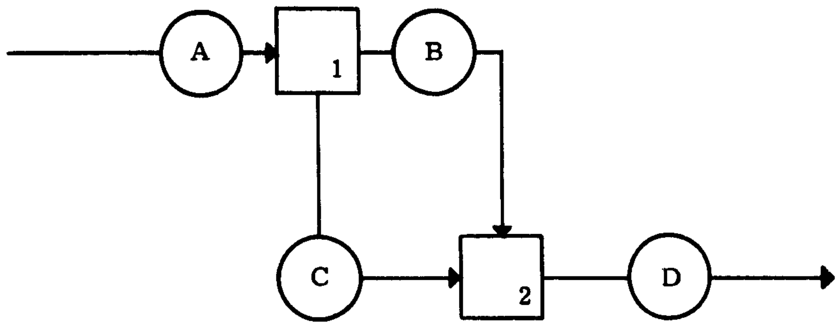
11. What does a box stand for in a troubleshooting diagram?

A box stands for a functional unit of the Fine Grain Data Section. That is, a box stands for something which must happen in a certain way within the Fine Grain Data Section in order for the whole system to operate properly.

12. What does a circle stand for in a Phase I troubleshooting diagram?

A circle stands for the location of a built-in indicator which can be read while the system is operating and which will give you information about whether or not the functions taking place in an operating T-2 are taking place correctly.

13. How do you use the GATHER, GUESS, CHECK strategy to carry out Phase I troubleshooting for the simple problem described by the troubleshooting diagram on the next page (Page 3A-5)? Assume that you have been given a signal that there is a malfunction somewhere in the system.



The first step in the strategy would be to GATHER information from all of the indicators (A, B, C, and D). The second step in the strategy would be to use the diagram to help you GUESS which box contains the malfunction. The third step in the strategy is the CHECK step. You will not learn about this step until later in the course.

Now go on to the Re-Test C which follows on Page 3A-6. Answer all of the questions in this re-test before scoring them. Instructions for scoring will follow at the end of the test.

RE-TEST C

1. What equipment will you be able to troubleshoot when you have finished this course?

____

____

2. When do you start Phase I troubleshooting?

____

____

____

3. What can you say about the location of the malfunction at the end of Phase I troubleshooting?

____

____

____

4. What is the reason for doing Phase I troubleshooting?

____

____

____

____

____

Go on to Question 5 on the next page.

RE-TEST C

5. Does this course teach you to do Phase II troubleshooting?

6. When do you use a strategy in Phase I troubleshooting?

7. What are the steps in the strategy which you will use?

8. What is the GATHER step?

9. What is the GUESS step?

Go on to Question 10 on the next page.

RE-TEST C

10. What is the CHECK step?

____

____

11. What does a box stand for in a troubleshooting diagram?

____

____

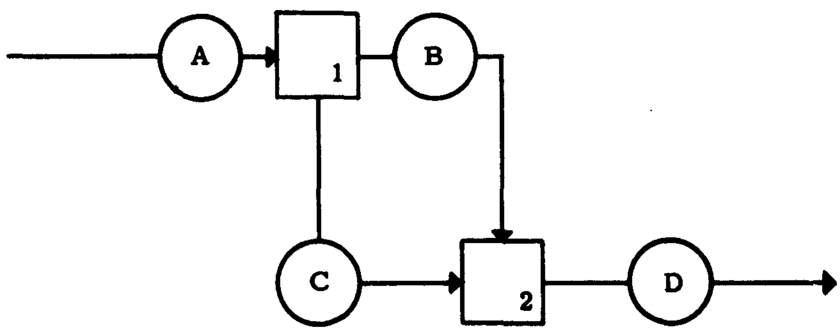
12. What does a circle stand for in a troubleshooting diagram?

____

____

13. How do you use the GATHER, GUESS, CHECK strategy to carry out Phase I troubleshooting for the simple problem described by the troubleshooting diagram below?

Assume that you have been given a signal that there is a malfunction somewhere in the system.



Write your answer to Question 13 on the next page.

RE-TEST C

The answers to the questions in this test may be found in LESSON 3A (Pages 3A-2 to 3A-5). Score your own test by comparing the answers that you have written with the answers which appear in this lesson. If you have answered all of the questions correctly, go on to LESSON 4 which starts on the next page. If any of the answers you have written are clearly incorrect, you should consult with your Course Monitor before going on to LESSON 4.

RE-TEST C

The answers to the questions in this test may be found in LESSON 3A (Pages 3A-2 to 3A-5). Score your own test by comparing the answers that you have written with the answers which appear in this lesson. If you have answered all of the questions correctly, go on to LESSON 4 which starts on the next page. If any of the answers you have written are clearly incorrect, you should consult with your Course Monitor before going on to LESSON 4.

LESSON 4

In this lesson you will learn:

1. How you can use a troubleshooting diagram to help you carry out the GATHER step in the troubleshooting strategy for any system.
2. What kind of information you must gather from each indicator that you will use in the GATHER step.
3. What you must do to carry out the GATHER step for Phase I troubleshooting of the Fine Grain Data Section.

LESSON 4

The GATHER step, as you learned in the last lesson, is the first step in the troubleshooting strategy. It is also the most simple step. For any system, the GATHER step has to do with gathering information from all of the indicators which must be used to make a GUESS in Phase I troubleshooting. The GATHER step starts as soon as you decide to do Phase I troubleshooting.

The purpose of the GATHER step is to obtain all of the information needed to make a GUESS as to the box which contains the malfunction. If you gather the wrong information, or if you gather too much or too little information, you may not be able to make a correct GUESS. The GATHERED information provides the basis for making a correct GUESS.

The information you must GATHER in Phase I troubleshooting of a particular system never changes from one troubleshooting problem to the next. For a system like the T-2, you must always GATHER information from the same indicators <u>every time</u> you carry out the GATHER step. This is because of the way in which the information that you must GATHER is related to the boxes which are shown in the troubleshooting diagram. In order to be able to GUESS which box contains the malfunction, you must consider <u>all</u> of the read-outs at once. The indicators and boxes shown on a Phase I troubleshooting diagram are carefully chosen so that:

1. If you GATHER information from <u>all</u> of the indicators shown by circles on the diagram....
2. You will be able to localize the trouble to one of the boxes shown on the diagram.

The indicators and boxes which are shown on the Phase I troubleshooting

diagram were chosen by engineers so that one of the boxes will be a correct GUESS if you use all of the information you GATHER.

If you do not GATHER information from all of the indicators, you will not have enough information to pin-down the trouble to a particular box. If you gather information from indicators which are not shown on the troubleshooting diagram, you may waste time gathering information that you do not need.

In regard to Phase I troubleshooting of the Fine Grain Data Section of the AN/FST-2, you should only GATHER the information from the indicators shown on the troubleshooting diagram which you will be given to use as a job aid at the end of this course. These indicators include the Warning Lights, the various PPI positions, and the RAPPI, and they are the only ones you should use.

One reason you should never GATHER more information than that provided by the indicators shown on your T-2 troubleshooting diagram is because there are literally thousands of places in the Fine Grain Data Section where you can collect information about its operation. The best place to GATHER information for Phase I troubleshooting is from the indicators shown on your troubleshooting diagram because those indicators provide just the information you will need to make a Phase I GUESS. The diagram may not include some of the read-outs that you have used in the past. For example, the Neon indicators will not be shown on your Fine Grain Data Section troubleshooting diagram because the information they present will not improve your ability to isolate a fault in Phase I troubleshooting -- and may even make it more difficult. That is, you will waste time and may even get confused if you attempt to use the information from the Neon indicators with the troubleshooting strategy you will be taught to use in this course.

You must remember two rules about gathering information in this troubleshooting strategy:

1. Always read all of the indicators shown on the troubleshooting diagram.
2. Don't spend time gathering information from other indicators; just gather information from the read-outs which are shown on the diagram.

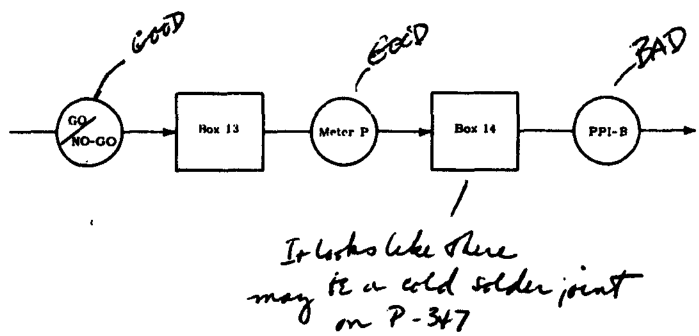
1. How can you tell what indicators to use in carrying out the Phase I GATHER step?

2. What indicators are used in the GATHER step for Phase I troubleshooting of the Fine Grain Data Section?
   1. ______________________
   2. ______________________
   3. ______________________

3. When you use a troubleshooting diagram to help you with the GATHER step, what are the two rules you should remember about gathering information for Phase I troubleshooting?

Turn to Page 28 in the ANSWER book.

Below is a Phase I troubleshooting diagram for a simple system. A technician who is trying to troubleshoot the system has written notes on the diagram telling what information he has collected about the way the system is operating.

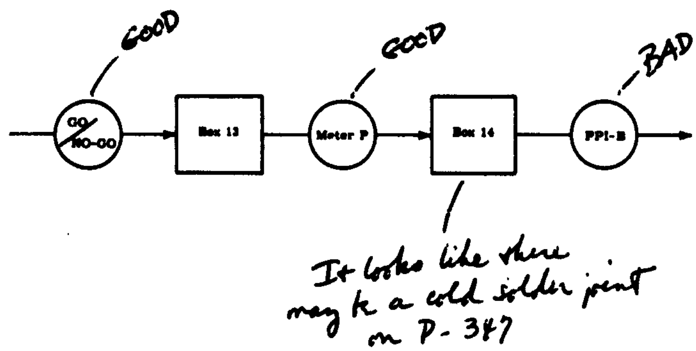


Use the diagram above to answer the following questions:

(a) List the indicators from which information should be GATHERED.

(b) List all of the possible GUESSES that could be made about the location of the trouble.

Turn to Page 28 in your ANSWER book.



Use the diagram above to answer the following questions:

(c) Will the information about the possible cold solder joint help to locate the trouble during Phase I?

(d) Should the technician have gone to the trouble of looking in the functional area called Box 14 during Phase I troubleshooting? Why?

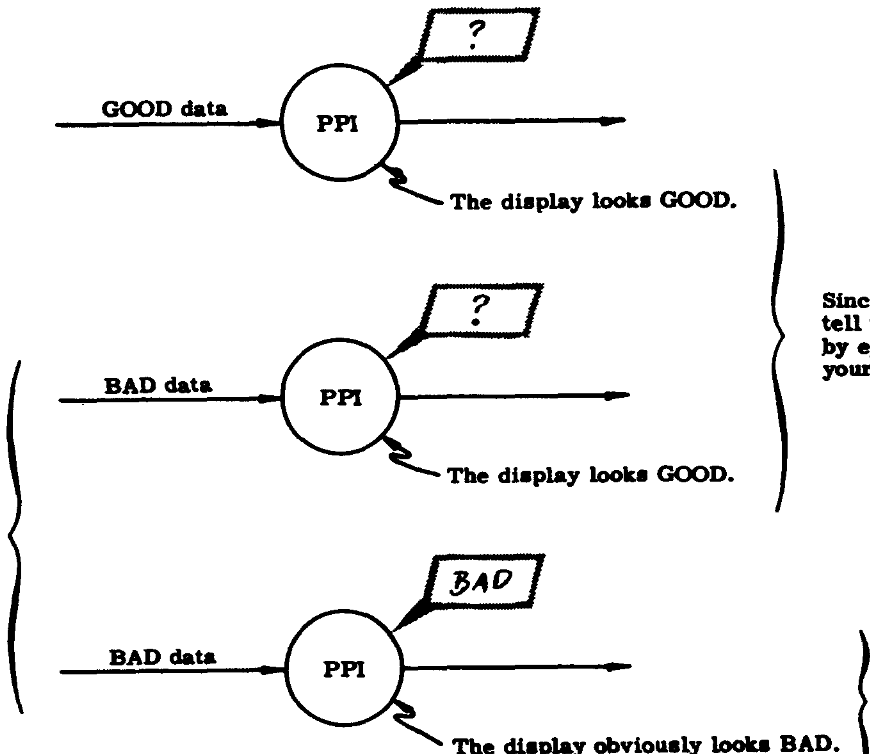
Turn to Page 38 in the ANSWER book.

Now you must learn what kind of information to record as a result of reading the indicators shown on your troubleshooting diagram. The easiest way to record your interpretation of a read-out is to record either GOOD or BAD. Whenever possible, the GATHER step in Phase I troubleshooting will call for the use of indicators that can be interpreted as GOOD or BAD. (An oil pressure light on an automobile instrument panel which glows red when the pressure is low, but which does not glow at all when the pressure is correct, is an example of an indicator that can always be interpreted as GOOD or BAD. Whenever the light glows while the motor is running, the interpretation must be: BAD.)

The Warning Lights which are used in Phase I troubleshooting of the Fine Grain Data Section are examples of GO/NO-GO indicators which can be interpreted as GOOD or BAD.

Unfortunately, however, it is not always possible to make inexpensive, reliable indicators which can be interpreted simply as GOOD or BAD. In the Fine Grain Data Section it has been necessary to use some complex indicators too, such as the PPI displays, for example. The PPI displays, and the RAPPI displays, which are used in Phase I troubleshooting of the Fine Grain Data Section are <u>not</u> GO/NO-GO indicators; rather, they are **?** /NO-GO indicators. That is, when you try to interpret a PPI reading, you will sometimes find that the display is obviously BAD or NO-GO, and you can record the read-out as BAD with a great deal of confidence. Other times, you will be unable to detect any bad signs on the PPI -- but that will not always mean that the display is GOOD. The display may be BAD, but you may be unable to find the bad feature of the display. It is especially true with PPI displays of processed target information that BAD displays may be difficult to detect simply because there is no one standard "correct" display which can be used for comparison. Thus a PPI display which is really BAD may not "look" bad. The table on the next page shows how you should record your interpretation of read-outs like PPI read-outs which are sometimes difficult to interpret.

Sometimes BAD data will cause the PPI display to be obviously BAD; other times, the PPI will not look bad to your eye even though it really is BAD.



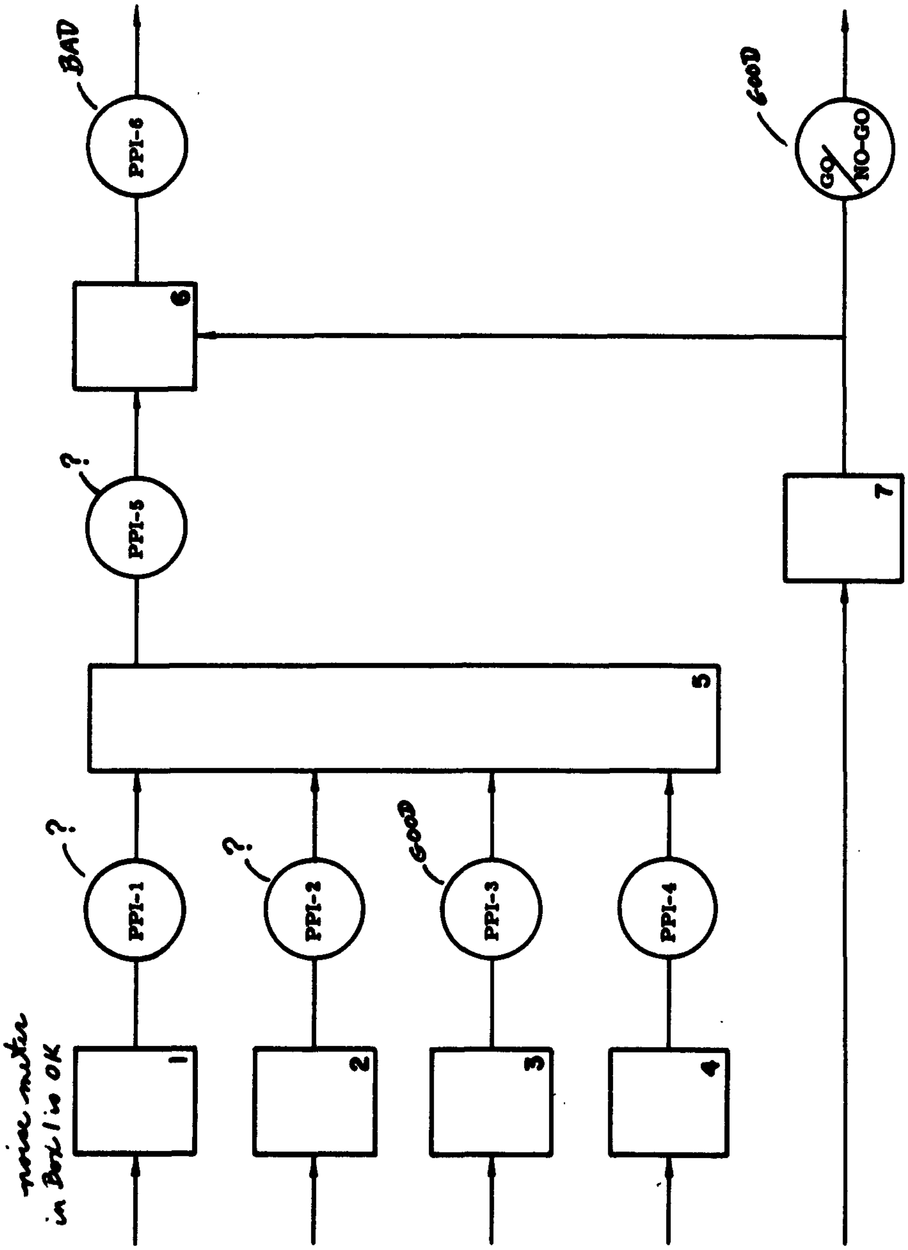
Since you cannot tell the difference by eye, record your read-out as: ?

Since a display which clearly looks BAD cannot be caused by GOOD data, record your read-out as: BAD

Thus, with a display like a PPI display of processed target data for which there is not a "standard," you should never record GOOD. If the display is obviously bad, you should record BAD; if the display looks GOOD or probably good, you should record ? . The ? will remind you that you may have made an error in reading the display, and the ? will, therefore, remind you to consider the possibility that the read-out is really BAD.

To review for the T-2, when you read the Warning Lights, the task of interpretation is simple. For example, if you have a V alarm, you need merely record the word BAD in the appropriate place on your troubleshooting diagram. If there is no alarm, you need merely write GOOD. Thus, for the Warning Lights, you will always write either GOOD or BAD. However, in the case of the PPI and RAPPI, the problem is more complicated. With these read-outs you must write BAD or ? . The reason for this is that you can never be sure that a PPI or RAPPI presentation is really GOOD. That is, the PPI and RAPPI presentations are difficult to interpret unless the signal is far out of tolerance, in which case it will look obviously BAD. Therefore, in order to avoid making a wrong GUESS, you should record ? if it appears to be good, and BAD if it is obviously bad.

Turn to the exercise on Page 4-11.


noise meter in Box 1 is OK
1
2
3
4
5
6
7
PPI-1
PPI-2
PPI-3
PPI-4
PPI-5
PPI-6
?
?
GOOD
?
BAD
GO/NO-GO
GOOD

The diagram at the left, on Page 4-10, is a simplified Phase I troubleshooting diagram of part of the Fine Grain Data Section. A technician who has carried out the GATHER step has written all of the information he has gathered on the diagram. He has made three mistakes in the GATHER step. Find all of these mistakes and tell why each one is a mistake in the space below.

1.

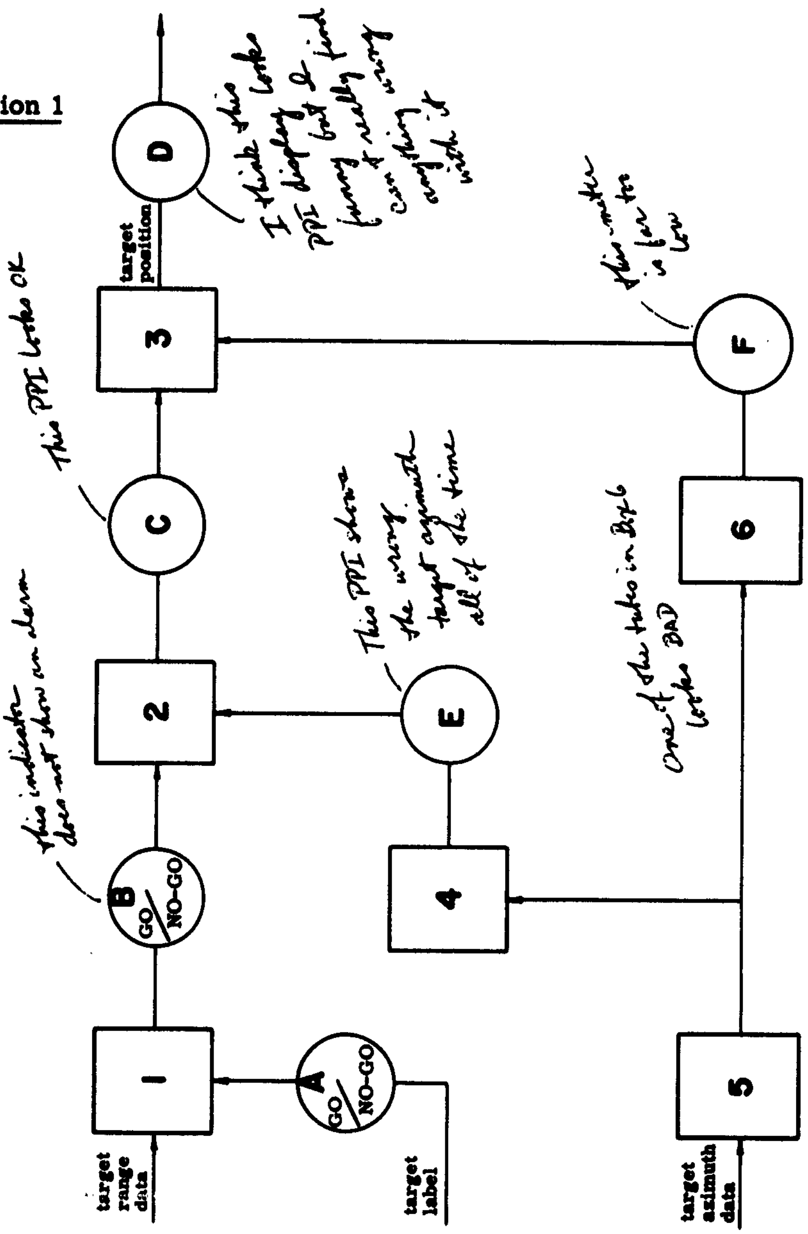
2.

3.

Turn to Page (31) in the ANSWER book.

TEST D

Question 1



See question on the next page, Page 4-13.

TEST D

Question 1

The Phase I troubleshooting diagram shown on Page 4-12, at the left, is for an imaginary system. A technician has written down the information he has GATHERED. In the space below, write down the letter or number of each box or circle from which he should have GATHERED information, and beside each one record what he should have written about each one.

Turn to Page 32 in your ANSWER book and score your own answer.

TEST D

<u>Question 2</u>

Fill in the blanks in the paragraph below by selecting the correct word for each blank from the list of words under the paragraph.

When you get a call from the DC indicating that something may be wrong with the Fine Grain Data Section, you must ________ Phase I troubleshooting. The first step will be to ________ all of the information you need to make a ________ about the ________ which contains the malfunction. You must GATHER information from _____ of the indicators shown on the Phase I troubleshooting diagram of the Fine Grain Data Section. You must ________ gather information from any other indicators. Neither should you omit any of the _______ shown on the troubleshooting diagram. If you GATHER information from all of the indicators, you will be able to consider all of the _____ at once and GUESS which _______ of the 28 functional areas shown as boxes in the Fine Grain Data Section troubleshooting diagram contains the ________. Each indicator shown as a ________ on the troubleshooting diagram must be ________ and the interpretation must be recorded to _______ the GATHER step. The Warning Lights are ______ indicators and each one must be always interpreted as ________ or ________. The PPI and RAPPI displays must be interpreted as BAD or as ________. The PPI and RAPPI displays must ________ be interpreted as GOOD because sometimes the bad

TEST D

feature of a display will be ________ to detect and a display which appears to be OK may ________ be BAD. The ? will remind you that a display which looks _____ may not be OK.

read-outs	GUESS	GO/NO-GO
start	really	indicators
never	circle	GOOD
one	box	BAD
GATHER	OK	all
hard	interpreted	not
malfunction	complete	?

Turn to Page 33 in your ANSWER book and score your own answer.

TEST D

Question 3

(a) What is the first step in the Phase I troubleshooting strategy?

(b) What is the signal to start that step?

(c) What is the purpose of that step?

(d) When you have gathered information from _____ indicator shown as a __________ on the trouble-shooting diagram, you will know that you have finished the GATHER step.

Turn to Page (34) in the ANSWER book and score your own answer.

LESSON 5

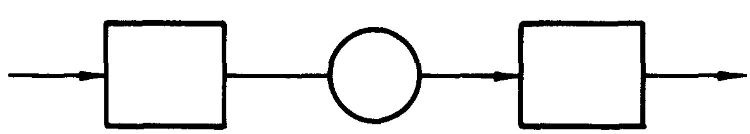
In this lesson you should learn:

1. To GUESS using combinations of in-line indicators.
2. To GUESS using combinations of Warning Lights and in-line indicators.
3. To make primary and secondary GUESSES.

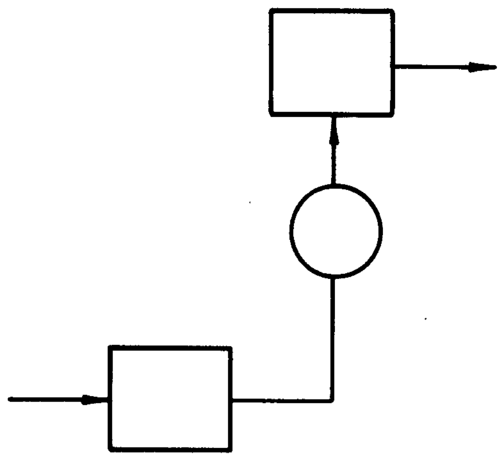
LESSON 5

This lesson is about the GUESS step in the Phase I troubleshooting strategy. In this lesson you will learn a number of rules for using the information that you GATHER, so that you will be able to make good GUESSES about where to find malfunctions.

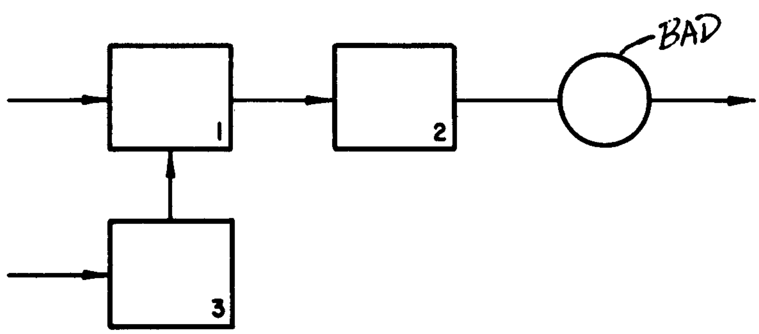
First, you must learn how to use in-line indicators. The indicator shown in the diagram below is an example of an in-line indicator. It provides a read-out of the information that is passed from one function to another in the main line of data flow. An in-line indicator is one which allows you to inspect the data in the system as it passes from one function to another. On a troubleshooting diagram, an in-line indicator will always appear on a line of data flow between boxes. An in-line indicator will always be "in line" with the boxes like this:



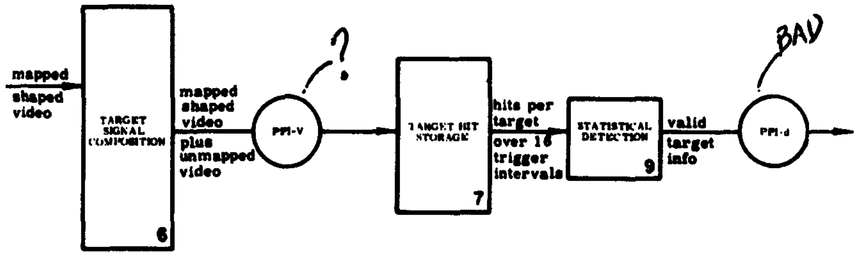
Sometimes an in-line indicator will look like this:



When an in-line indicator displays a bad signal, you should guess that the malfunction which causes the bad signal is <u>somewhere</u> in one of the functions before the read-out. For example, if the in-line indicator in the figure below gives a BAD read-out, then you should guess that any one of the three boxes might contain the malfunction that caused it.



A bad in-line indicator read-out means that there is trouble in some function prior to the read-out; but unless there is some way to check the prior line of data flow, you cannot tell which one of the prior boxes contains the trouble. For instance, consider the example shown in the diagram below, which is taken from a portion of the T-2.



Suppose that PPI-d definitely looks BAD in comparison to PPI-V, but PPI-V appears OK as far as you can tell. What would be your GUESS about the location of the malfunction causing the BAD PPI-d? Is the trouble in Box 7, or in Box 9, or perhaps in Box 6? Don't forget that you may GUESS the trouble is equally likely to be in one of two boxes, if you haven't enough information to GUESS which of the two really contains the trouble. Answer: ____________________

Turn to Page 35 in the ANSWER book.

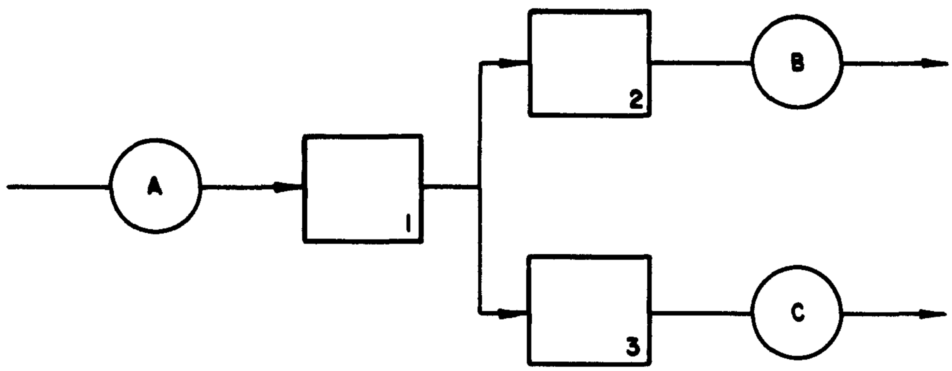
When you use the kind of information that is provided by in-line indicators in order to make a GUESS about the location of a malfunction, you should remember that a BAD read-out of an in-line indicator merely means that the trouble is somewhere prior to the BAD read-out. Using only the BAD read-out you cannot tell which one of the prior boxes contains the trouble. In order to pin down the trouble to one box, you must be able to bracket that box by a GOOD read-out on the input side and a BAD read-out on the output side, if you are using only the in-line indicators.

The use of in-line indicators to bracket a box with a good input and a bad output is the most simple rule that you will use in trying to GUESS the location of a malfunction. You will find with most systems, however, that you cannot go very far in your troubleshooting if this is the only rule you use. Thus, very few systems are provided with enough in-line indicators to bracket every box in the troubleshooting diagram. Therefore, you must learn to use some other principles for making GUESSES about the location of a malfunction.

Notice that when you use in-line indicators in order to pin down the location of a malfunction, you must always use a combination of at least two indicators, one on the input side and one on the output side. In general, whenever you are attempting to make a GUESS about the location of a malfunction, you will need to use combinations of read-outs in order to locate the bad box. That is one reason why it is good to GATHER all of the information that you need before you try to make a GUESS. By gathering all of the information first, you will be able to use combinations of read-outs when you are GUESSING.

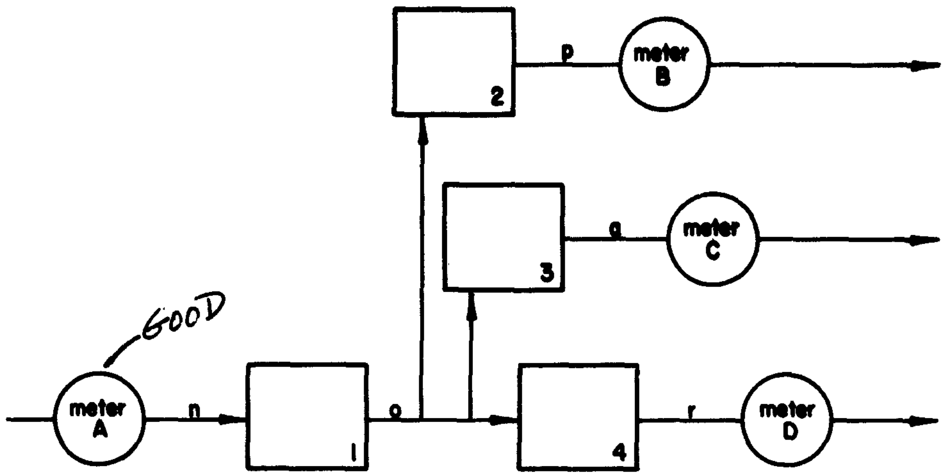
What are some of the other ways in which you can use combinations of read-outs in order to make GUESSES? One way is exemplified in the figure shown on the next page.

Turn to Page 5-6 and continue with the lesson.



The figure above shows a simple system with three subsystems and three indicators. In this system, the output of Box 1 splits and goes to two other boxes -- Box 2 and Box 3. This arrangement of boxes is called a divergent chain. When one output signal splits in this way, you can use a special combination of read-outs to isolate the source of trouble. For example, by using the read-outs at B and C in combination, you can determine whether a trouble is in Box 1, 2, or 3 even though there is no indicator between Box 1 and Box 2. In the next exercise you will learn how to do this.

Turn to the exercise on the next page.



The output of Box 1 is <u>divergent.</u> That is, line o goes to three different boxes. Meter A looks OK; therefore, assume the data on line n are OK. Fill in the following table:

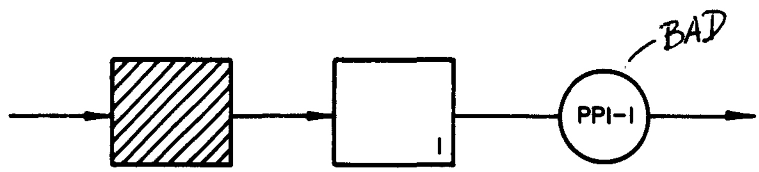
If there is a malfunction in:	The meter read-outs will be: (Fill in either GOOD or BAD).		
	Meter B	Meter C	Meter D
Box 1			
Box 2			
Box 3			
Box 4			

Turn to Page 36 in the ANSWER book.

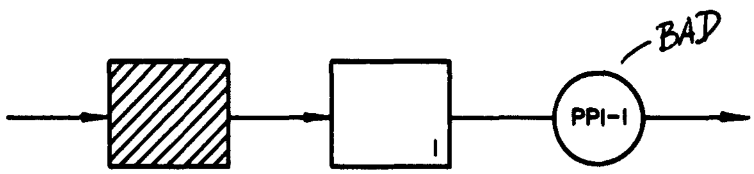
Now you can better understand why the first step in the troubleshooting strategy is to GATHER all of the information that you need to make a GUESS. The reason is that you need combinations of read-outs in order to get enough information to make a good GUESS.

Can you narrow down the location of a malfunction to a single box without a combination of read-outs? The answer in every case is NO. For example, if you have one box and one in-line read-out, with the read-out on the input side, you cannot tell anything about how that box is functioning, no matter what you read out from the indicator. If the indicator reading is GOOD, the box which follows it may still have a malfunction; if the indicator read-out is BAD, you still do not know anything about the box because it comes after the read-out.

Suppose you have only one in-line read-out on the output side of a box, as shown in the figure below.



You still cannot narrow down your GUESS to Box 1. The reason for this is that a BAD indication could be caused by a malfunction in a box somewhere before the box shown in the figure. That is, the malfunction could be located in a box outside of the system. A box or function outside of the system is shown by a shaded box in the figure above. A malfunction in the shaded box could be causing the BAD read-out on the output side of Box 1. Therefore, no matter where you place one indicator, you cannot use your read-out to narrow down the malfunction to a single box for certain.

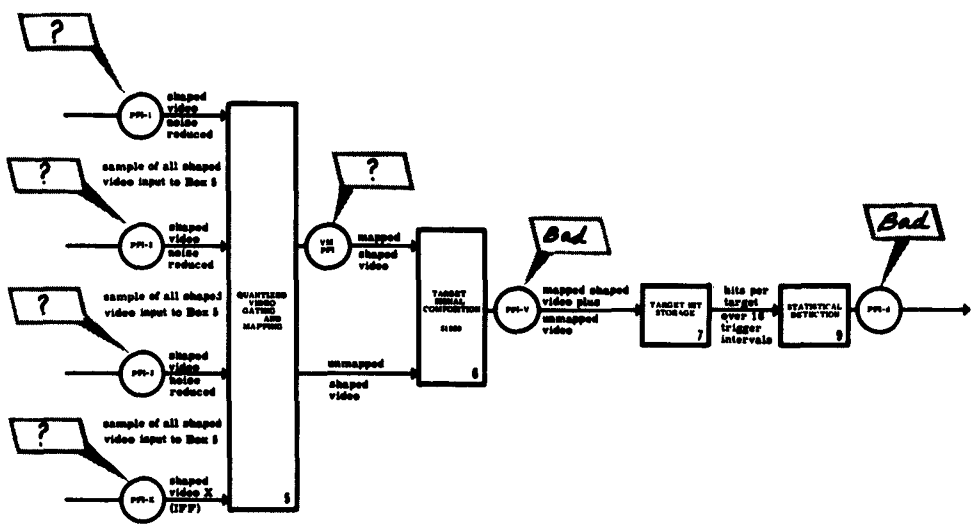


In the problem shown by the figure above, your GUESS should be: "The malfunction is in Box 1, or in some function prior to Box 1 outside of the system."

In the example above, your GUESS about the location of a malfunction would have to include two possible locations: a box outside of the system and Box 1. Sometimes you cannot avoid making a GUESS which includes two possible boxes. Sometimes, the combination of read-outs that you GATHER will not make it possible for you to narrow down the location of a malfunction to a single box. When you cannot narrow down the location to a single box, you may, however, feel that the trouble is more likely to be in one box than in another. In this case, you have to make a GUESS that has two parts: a primary GUESS and a secondary GUESS. The primary GUESS identifies the box which you think is more likely to contain the trouble. The secondary GUESS identifies the box which you would look at next, if your primary GUESS turns out to be wrong. Whenever you find that you cannot narrow down your GUESS to a single box, you should go ahead and make both a primary GUESS and a secondary GUESS because the CHECK step, which you will learn about next, is designed to help you decide which GUESS is the correct one. Thus, even if you make two GUESSES about the location of a malfunction, in most cases you will be able to sort out the right GUESS before you are finished with Phase I troubleshooting.

Here is an example of a typical situation in which you must use

in-line indicators to make a GUESS, but where you cannot pin down the location of the malfunction to a single box on the basis of your in-line read-outs alone.



Turn to the exercise on the next page.

The diagram on Page 5-10 is a trouble-shooting diagram of a small part of the Fine Grain Data Section. The information that has been GATHERED from the indicators in this section is shown on the diagram. Make the best GUESS you can about the location of the malfunction in this part of the Fine Grain Data Section.

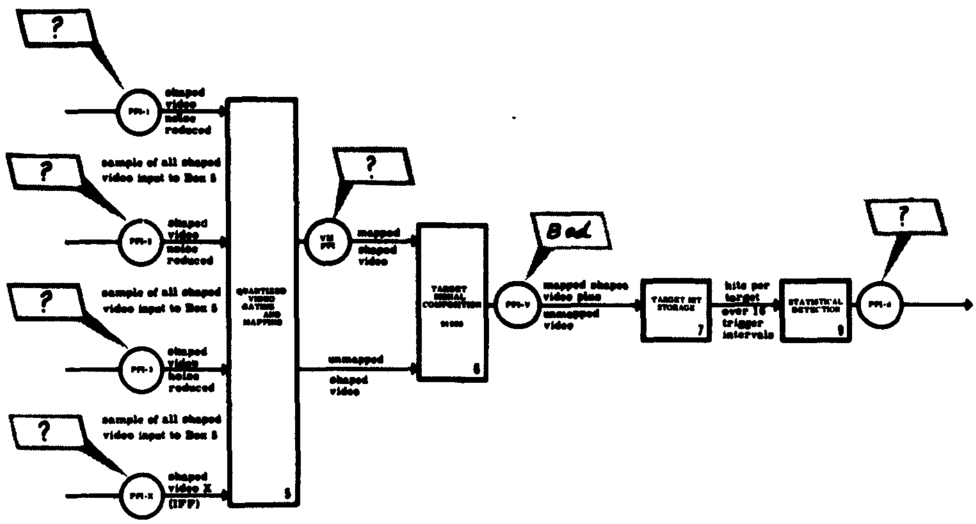
Answer: ____________________________

Turn to Page 37 in the ANSWER book.

In the example above, if PPI-V is BAD, this means that bad data is being passed through Box 7 and through Box 9; therefore, PPI-d should also be BAD, as shown in the figure on Page 5-10. However, in a real troubleshooting situation, where there is actually a malfunction in Box 5 or in Box 6, and PPI-V is obviously BAD, you might not be able to see any indication of a malfunction at PPI-d and you might write a ? as your interpretation of PPI-d.

Turn to the exercise on the next page.

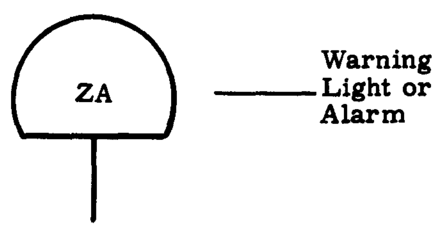
Suppose that you have GATHERED the information shown in the figure below. What is your GUESS about the location of the malfunction?



Turn to Page 38 in the ANSWER book.

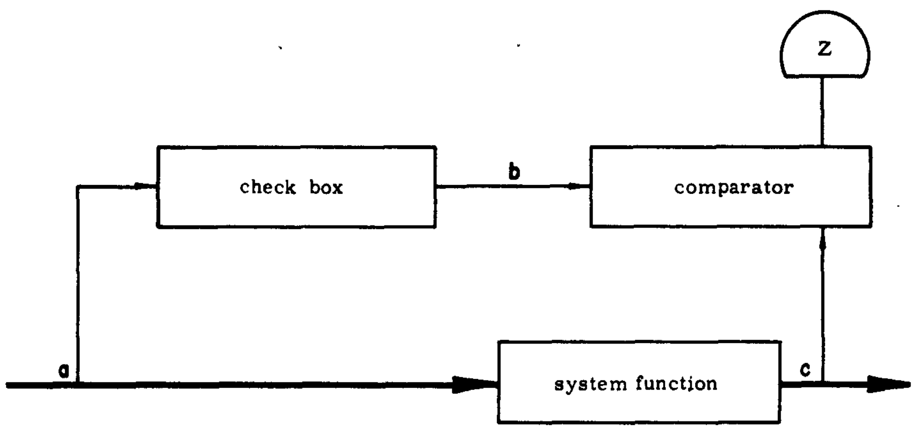
So far we have been talking about the rules for GUESSING when you are using in-line indicators. There is another kind of indicator that you need to know about, however. These indicators are the Warning Lights which are GO/NO-GO indicators. When you GATHER information from the Warning Lights, you record your interpretation either as GOOD or as BAD.

You have just learned that in-line indicators, which are represented by circles on the troubleshooting diagram, tell you whether or not a main line of data is BAD at a given point in the system. Thus, in-line indicators tell you about lines of data flow. A Warning Light, on the other hand, tells you about an area of the system, rather than about a line of data flow. Thus, when you see a BAD Warning Light, you can make a GUESS that the malfunction which caused the signal is in a certain area of the system, rather than on a certain line of data flow. In order to call attention to this difference between the Warning Lights and in-line indicators, Warning Lights are represented by semi-circles on the troubleshooting diagram.



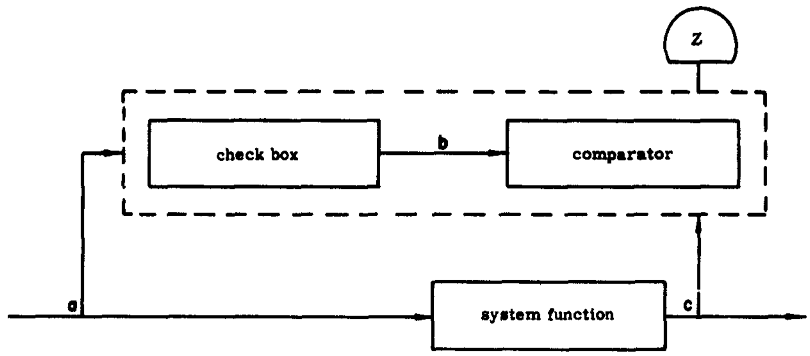
A Warning Light is associated with a check box, which is an off-line box that does not carry out any essential processing of the data in the system. The term "check box" may be a poor name because the check box does not really check the performance of a system function. Rather, a check box merely performs a similar operation on the same input as that received by the in-line system function, and when the outputs of the check box and the in-line function are not equivalent, a

Warning Light comes on to tell you that something has happened in one of the boxes causing the outputs to be different. Now let us see how this looks when expressed in a diagram.

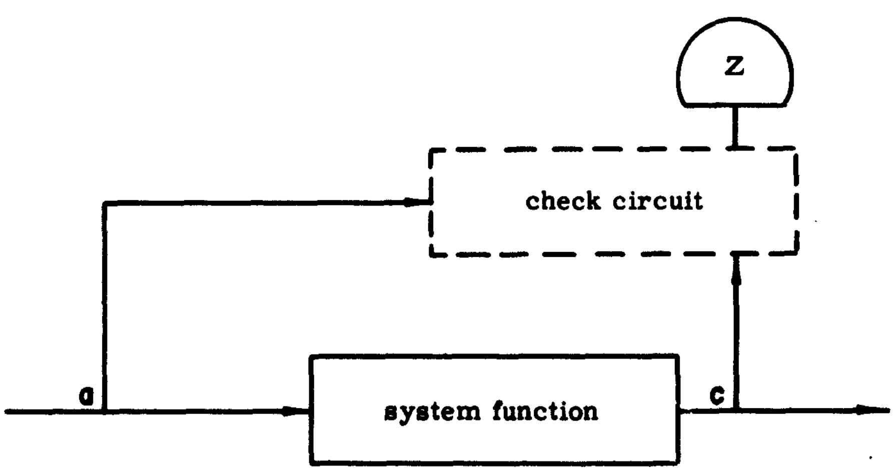


The main line of data flow is represented by the heavy line. You can see that the main line system function and the check box both operate on the same input signal. They are designed to perform their operations such that when the outputs from both of these boxes are compared by the comparator they will be identical for all practical purposes. If they are not, the Warning Light will come on. However, this does not mean that the check box and the system function treat the signal in an identical fashion. Therefore, if the input signal is very far out of tolerance, it may cause the Warning Light to come on. If the input signal is just slightly out of tolerance, it will probably not light the Warning Light, but will cause the next in-line indicator to read BAD.

Notice that the Warning Light does not monitor the main line of data flow and therefore is not considered an in-line indicator. The Warning Light will appear as a semi-circle on your troubleshooting diagram to make it easy for you to distinguish it from the circles which represent the in-line indicators.

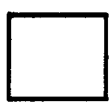
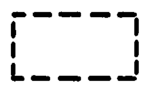
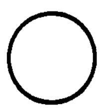


Examine the diagram above. Notice that it is similar to the previous diagram except for the fact that there is a dotted line around the check box and the comparator. Notice also that there is no read-out (circle or semi-circle) on line b, which connects the check box and the comparator. Since there is no read-out, we cannot isolate a failure during Phase I troubleshooting to the check box as opposed to the comparator. Therefore, the two are combined on the troubleshooting diagram as shown below and labeled "check circuit."

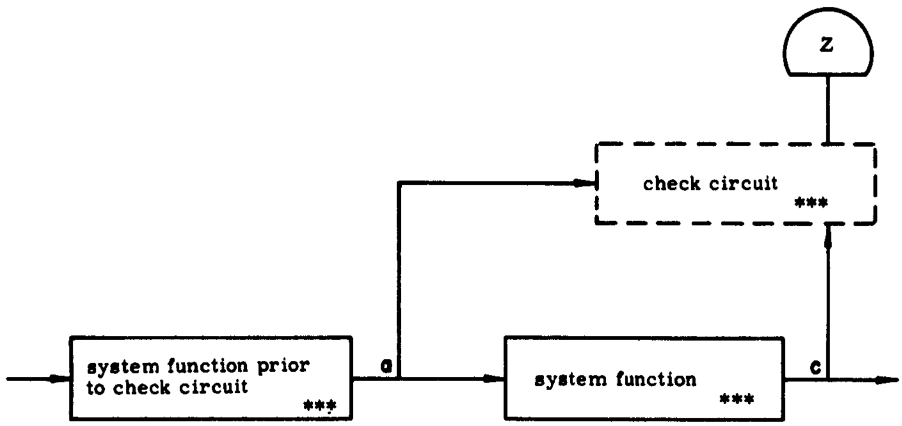


Notice that the combined check circuit/comparator function is not in the main line of data flow. Therefore, we have made it a dotted line box on the troubleshooting diagram to help you to distinguish it from the main line functions which are identified by solid line boxes. Remember, the Warning Lights are shown as semi-circles on the troubleshooting diagram for the same reason, i.e., to help you to distinguish them from the main linė read-outs which are represented by circles.

Remember these relationships:

Main Line of Data Flow		Not on Main Line of Data Flow	
Symbol	Meaning	Symbol	Meaning
	System Functions		Check Circuits
	PPI positions and RAPPI (in-line indications)		Warning Lights

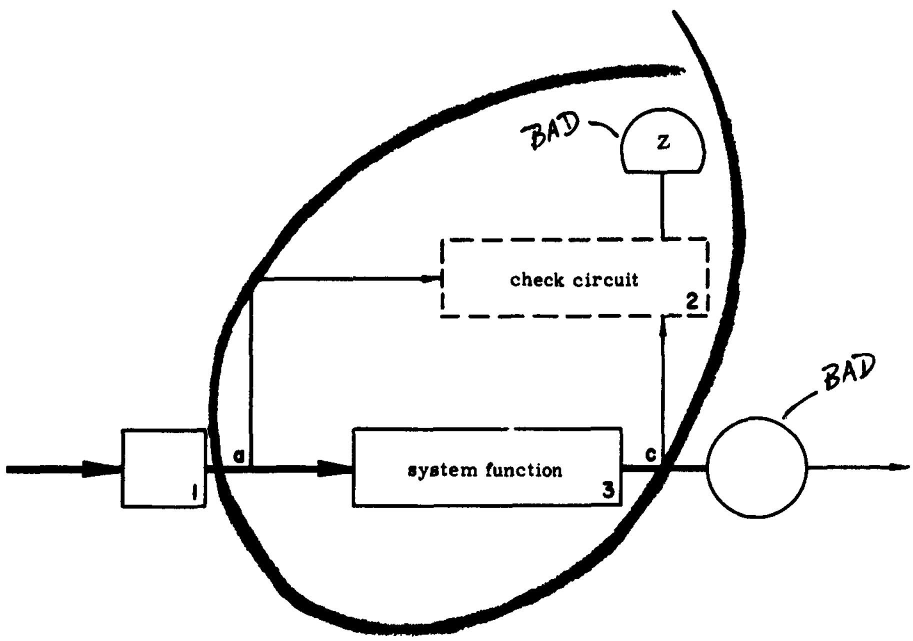
A Warning Light monitors the functioning section of a system which is composed of a system function and a check circuit. If a Warning Light occurs, you can GUESS that the trouble is in: 1) the system function, 2) the check circuit, or 3) in a prior function which causes a bad signal to be sent to the area being checked, as shown in the diagram on the next page.



***Possible locations of a malfunction if Z is BAD.

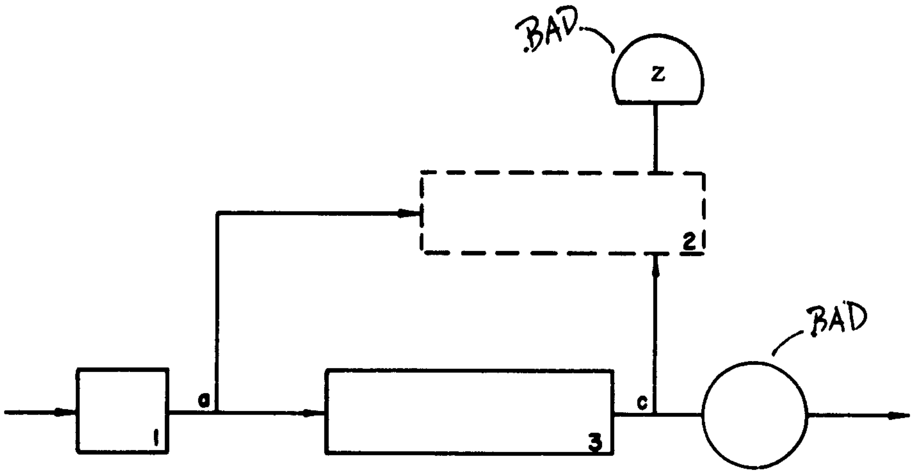
However, in the absence of any other information you cannot GUESS which of the three possible locations is actually causing the malfunction. In order to tell whether the fault is in the check box, or in a main line function, you must use a combination of indicators. You must use both the Warning Light read-out and a read-out of an in-line indicator, in combination, to GUESS whether the trouble is located in the check box or in the in-line function.

Turn to the next page and continue the lesson.



For example, an alarm in the system described by the diagram above plus a BAD read-out of the in-line indicator would lead you to GUESS that the trouble is most likely in the system function, Box 3 -- or possibly in Box 1. The alarm tells you that the trouble is most likely to be within the area of the system that is enclosed by the circle around Box 2 and Box 3. The BAD in-line indicator tells you that the trouble is somewhere along the data flow line prior to the indicator as shown in the diagram by the heavy line which goes through Box 1 and Box 3. Thus, if the trouble were in Box 3, it would cause the combination of read-outs: BAD Warning Light, BAD in-line indicator.

Turn to the next page and do the exercise.



Do this exercise on the diagram above.

(a) Draw a heavy line along the lines of data flow which could be causing the BAD in-line read-outs.

(b) Draw a circle around the boxes which could cause the BAD Warning Light.

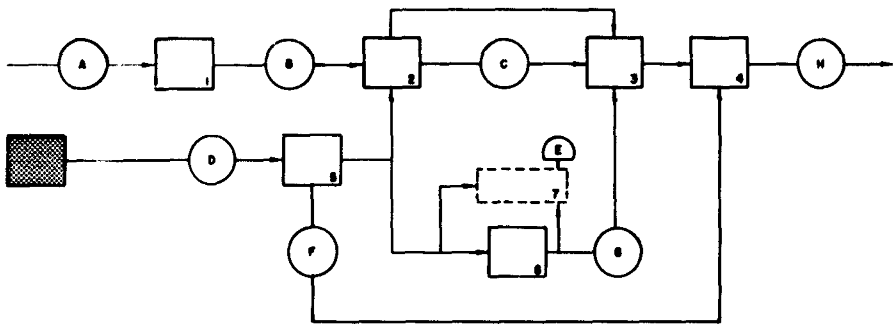
(c) GUESS which box is <u>most likely</u> to contain the malfunction.

Turn to Page 38 in the ANSWER book.

TEST E

Question 1

(a) Identify all of the in-line indicators from which you would GATHER information to start troubleshooting the system described in the diagram below.



Turn to the next page and continue this question.

Using the diagram on Page 5-20:

(b) Identify all of the Warning Lights.

(c) Identify all of the check boxes.

(d) Identify all of the functions which are shown on the diagram, but which are <u>not</u> part of the system.

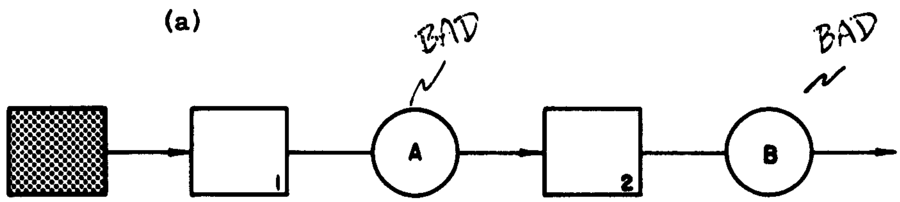
Turn to Page 40 in the ANSWER book.

TEST E

Question 2

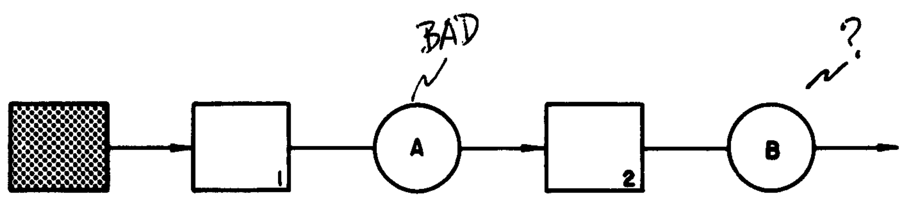
What is the best GUESS you can make about the location of the malfunction in each of the examples below? Assume there is only one malfunction in each problem.

(a)



Best GUESS: ______________________________

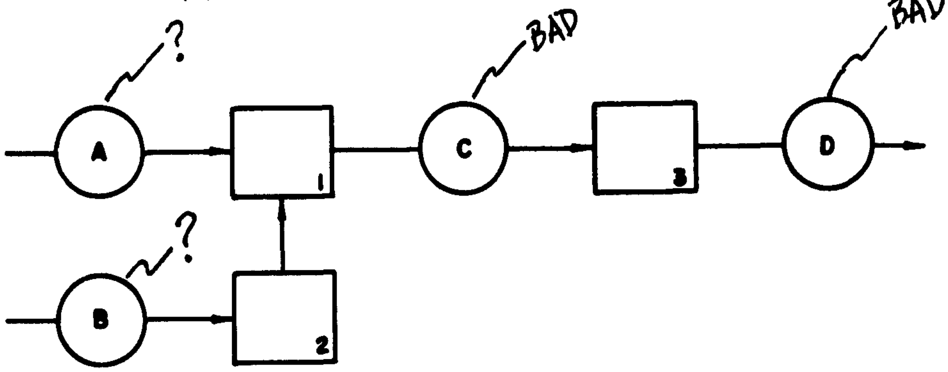
(b)



Best GUESS: ______________________________

Turn to the next page and continue the question.

(c)



Best GUESS: ______________________________

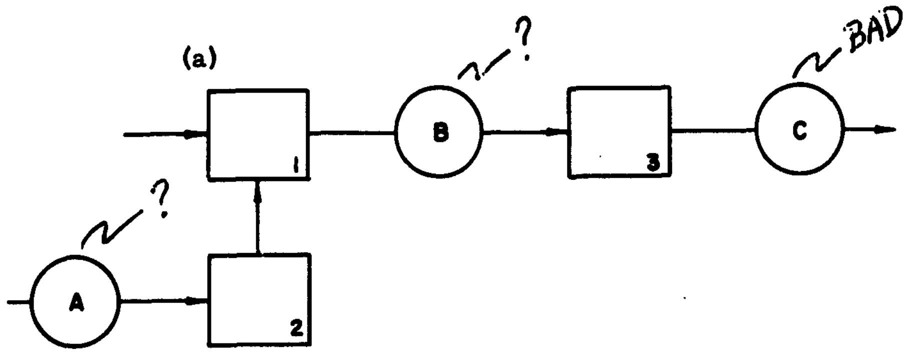
Turn to Page 41 in the ANSWER book.

TEST E

Question 3

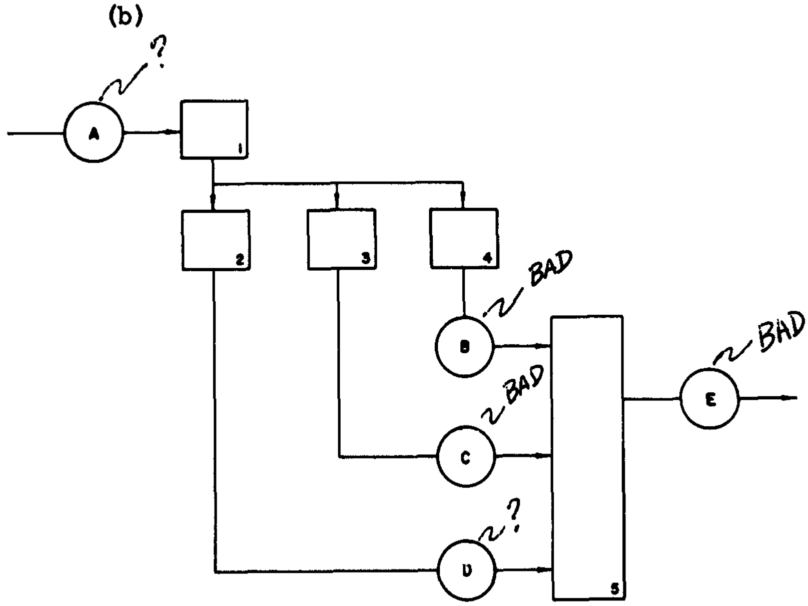
What is the best GUESS you can make about the location of the malfunction in each of the examples below? Assume there is only one malfunction in each problem.

(a)



Best GUESS: ____________________

(b)



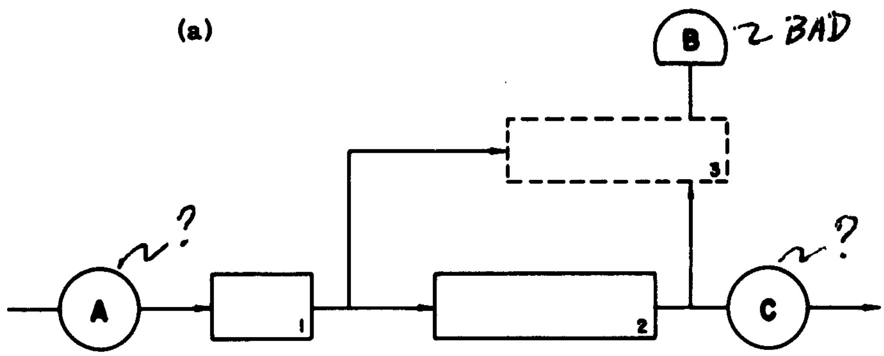
Turn to Page 42 in the ANSWER book.

TEST E

Question 4

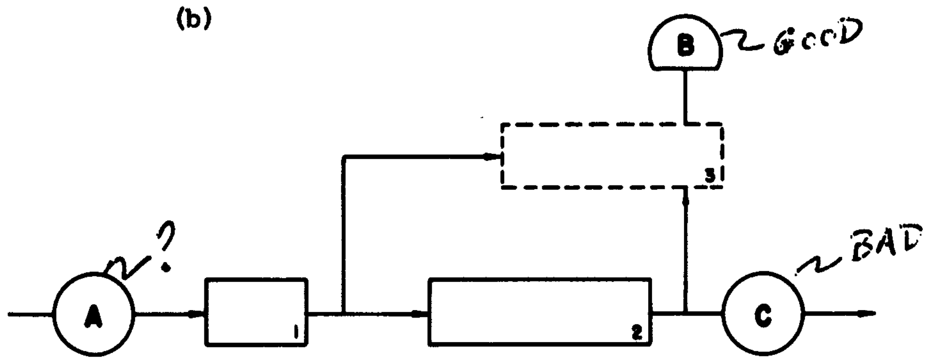
What is the best GUESS you can make about the location of the malfunction in each of the examples below? Assume there is only one malfunction in each problem.

(a)



Best GUESS: ______________________________

(b)



Best GUESS: ______________________________

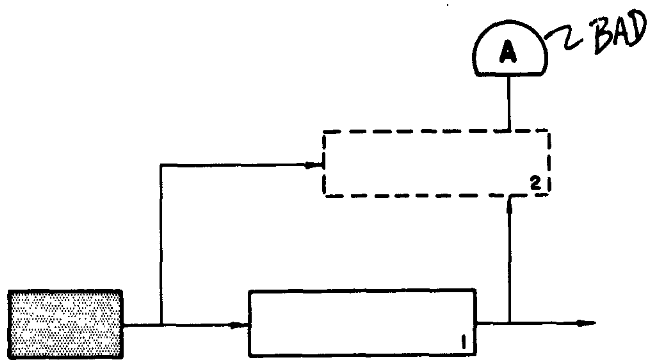
Turn to Page 43 in the ANSWER book.

TEST E

Question 5

What GUESS would you make about the location of the malfunction in each of the problems below?

(a)



Primary GUESS: ______________________

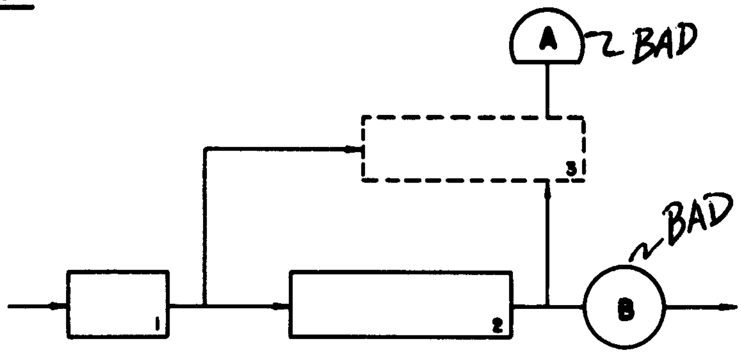
Secondary GUESS: ______________________

(b) Suppose you know that there is NO trouble in Box 1 or in Box 2 in the example above. What would you guess about the location of the malfunction?

Turn to Page 44 in the ANSWER book.

TEST E

Question 6



What is your primary GUESS about the location of the malfunction in the diagram above?

Primary GUESS: ____________________

What is your secondary GUESS? __________

____

Turn to Page 45 in the ANSWER book.

Question 7

In Question 6 above, why is Box 2 the correct primary GUESS rather than Box 1?

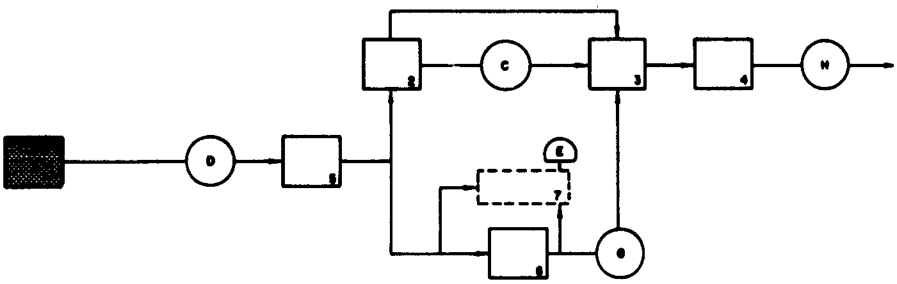
Turn to Page 46 in the ANSWER book.

DO NOT TAKE THIS TEST UNLESS YOU WERE INSTRUCTED TO DO SO ON PAGE 46 IN YOUR ANSWER BOOK

RE-TEST E

Question 1

(a) Identify all of the in-line indicators from which you would GATHER information to start troubleshooting the system described in the diagram below.



Turn to the next page and continue this question.

Using the diagram on Page 5-28:

(b) Identify all of the Warning Lights.

(c) Identify all of the check boxes.

(d) Identify all of the functions which are shown on the diagram, but which are not part of the system.

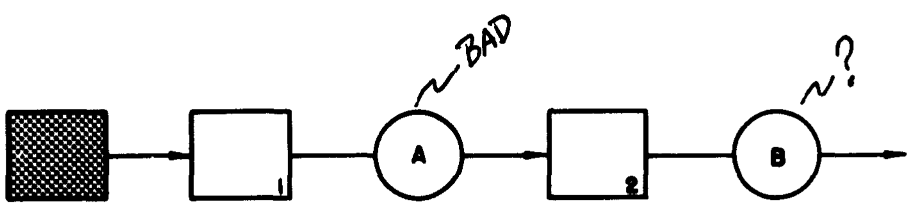
Turn to Page 47 in the ANSWER book.

RE-TEST E

Question 2

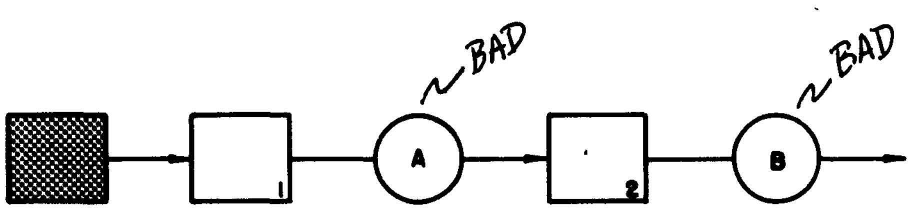
What is the best GUESS you can make about the location of the malfunction in each of the examples below? Assume there is only one malfunction in each problem.

(a)



Best GUESS: ______________________________

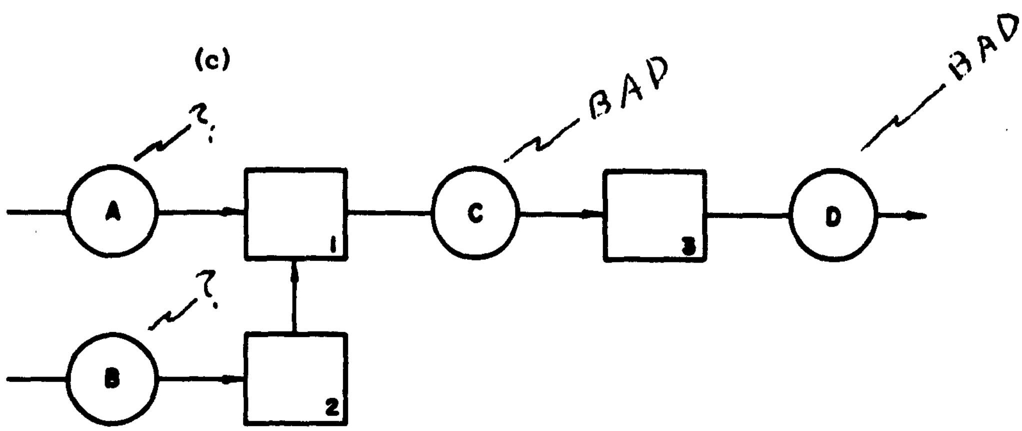
(b)



Best GUESS: ______________________________

Turn to the next page and continue this question.

(c)



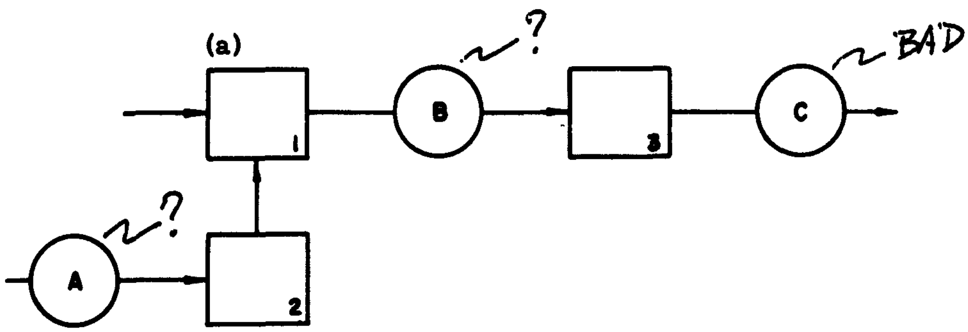
Best GUESS: ______________________________

Turn to Page 48 in the ANSWER book.

Question 3

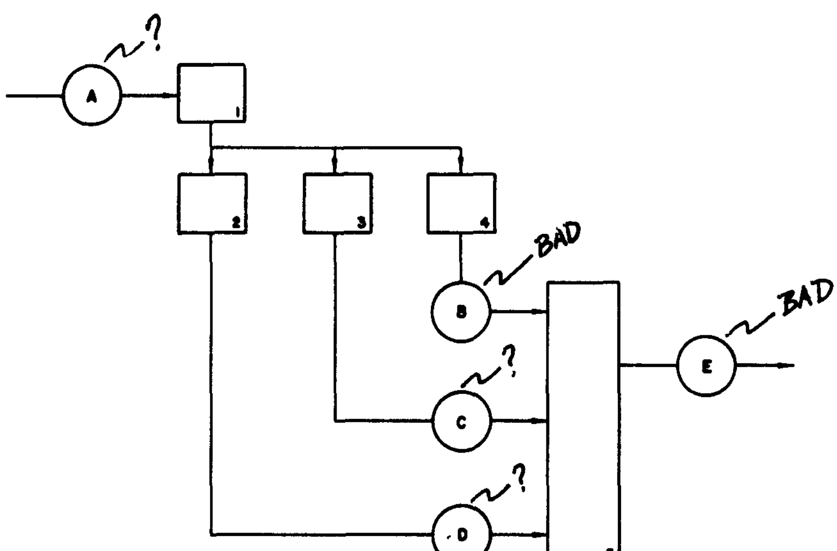
What is the best GUESS you can make about the location of the malfunction in each of the examples below? Assume there is only one malfunction in each problem.

(a)



Best GUESS: ______________________

(b)



Best GUESS: ______________________

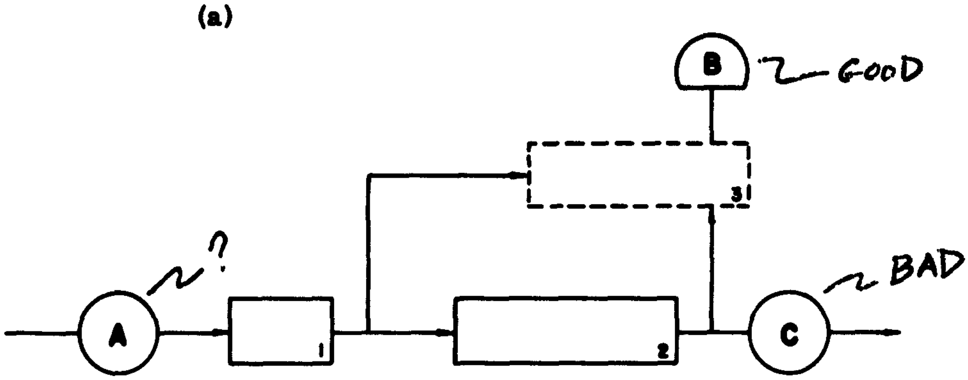
Turn to Page 40 in the ANSWER book.

RE-TEST E

<u>Question 4</u>

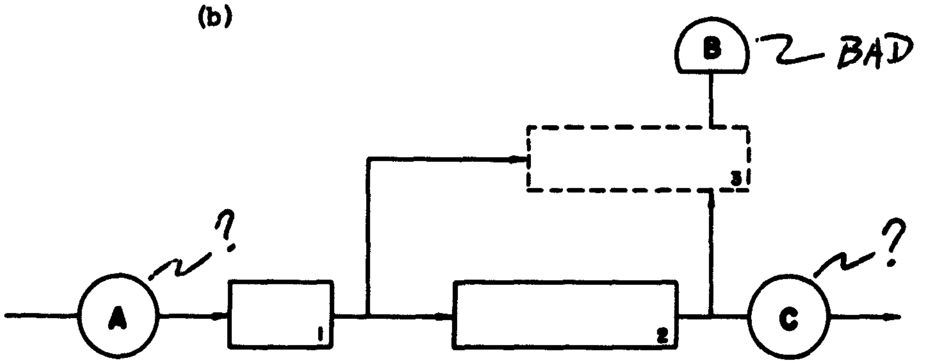
What is the <u>best</u> GUESS you can make about the location of the malfunction in each of the examples below? Assume there is only one malfunction in each problem.

(a)



Best GUESS: ____________________

(b)



Best GUESS: ____________________

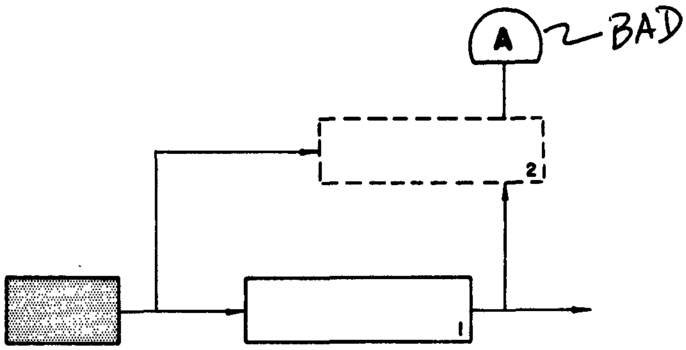
Turn to Page [illegible] in the ANSWER book.

RE-TEST E

Question 5

What GUESS would you make about the location of the malfunction in each of the problems below?

(a)



Primary GUESS: ______________________

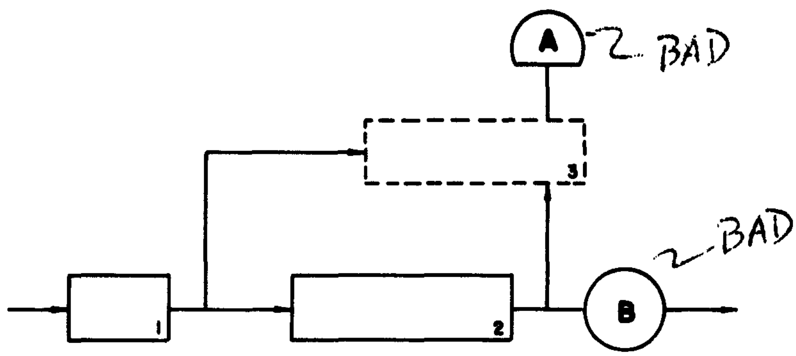
Secondary GUESS: ______________________

(b) Suppose you know that there is NO trouble in Box 1 or in Box 2 in the example above. What would you guess about the location of the malfunction?

Turn to Page 51 in the ANSWER book.

RE-TEST E

Question 6



What is your primary GUESS about the location of the malfunction in the diagram above?
Primary GUESS: ______________________

What is your secondary GUESS? ______________________

Turn to Page 52 in the ANSWER book.

RE-TEST E

<u>Question 7</u>

(a) Can a bad input to the area checked by a check circuit cause an alarm?

(b) When you have an alarm, is it more likely to be caused by a malfunction within the area checked by the alarm <u>or</u> by a bad input to the area?

Turn to Page 53 in the ANSWER book.

LESSON 6

In this lesson you will learn:

Why you must use the CHECK step in the troubleshooting strategy.

LESSON 6

Suppose you are working on a troubleshooting problem and you have made a GUESS, in Phase I, about the functional unit or box which contains the malfunction. What would happen if you had made a wrong GUESS? The answer is that you would waste a lot of troubleshooting time. The waste of time is obvious if you consider what would happen in Phase II troubleshooting when you have made an incorrect GUESS during Phase I. If your Phase I GUESS had been wrong, you would start Phase II troubleshooting in the wrong functional area and you would, of course, have a great deal of difficulty trying to find an answer to your Phase II troubleshooting problem. In the case of the T-2, Phase II troubleshooting involves the use of the oscilloscope which can take a lot of time. To avoid this loss of time, it would be very good to have some way to make certain that your GUESS for Phase I is correct before you go on to Phase II troubleshooting. What you need is a CHECK of your GUESS for Phase I that would tell you whether or not the GUESS is correct. The reason for the CHECK step in the troubleshooting strategy is, therefore, to make sure that your GUESS for Phase I has been correct before you start Phase II troubleshooting.

We said the purpose of a CHECK is to make <u>sure</u> that the GUESS for Phase I has been correct. The fact of the matter is, we can never be <u>sure</u> that a GUESS has been correct until the system has been repaired and has been put back on the air. Actually, we mean that we want to be highly <u>confident</u> that the GUESS has been correct. The difference between being <u>sure</u> about a GUESS and being <u>confident</u> is important in the troubleshooting strategy because it is the degree of confidence which determines whether or not we need a CHECK.

Therefore, let us talk a bit more about what confidence means.

There are very few things in this world about which you can be sure. For example, you cannot be sure that the world will continue to turn around on its axis for another year; but you may be very confident that it will do so, and, your confidence in this fact may be extremely high. There are some other facts about which you may be less confident. For example, if the sun is shining at noon and the sky is clear, you may be quite confident that it will not rain by one o'clock; but your confidence that it will not rain by one o'clock will be less than your confidence that the world will continue to go around. Then there may be some things about which you are not very confident at all. For example, if you are caught in a traffic jam on your way to catch a train, you may have very little confidence that you will get to the station on time. Thus, you can see that your confidence may vary from low to high depending on the situation. It is the same way with the GUESS that you will make during Phase I about the location of the malfunction in a system. Sometimes the GUESS you make about a malfunction will be based on very good information and you will have high confidence that your GUESS is correct even if you do not CHECK it. Other times, the GUESS you make will be based on very poor information and you will have very little confidence that it is correct.

It is clear that the real purpose of the CHECK step in troubleshooting strategy is to provide you with confidence that your GUESS has been correct. If you make your GUESS for Phase I on the basis of very good information, you may have so much confidence in the GUESS that you will not need to make a CHECK. On the other hand, very often the GUESS that you make during Phase I will be based on poor information, and may be wrong. When the GUESS is based on poor information and your confidence that it is correct is low, you will want to perform some kind of CHECK to find out if it is correct. Then if your CHECK agrees with the GUESS, you will have high confidence that the GUESS has been correct. On the other hand, if your CHECK does not agree with the GUESS, you will lose all confidence in the GUESS and you must make

a new GUESS. Remember, you want to be confident that your Phase I troubleshooting GUESS has been correct so that you will not go on to Phase II on the basis of an incorrect GUESS. If you have high confidence that your GUESS for Phase I is correct, you will be unlikely to start Phase II troubleshooting in the wrong box; therefore, you will be unlikely to waste a lot of time in your Phase II troubleshooting.

1. Why should you CHECK your Phase I troubleshooting GUESS before you go on to Phase II?

2. If you were very confident that your Phase I GUESS were correct even without making a CHECK, would it be necessary to make a CHECK?

3. If you use the GATHERED information to make a GUESS, can you CHECK that GUESS by GATHERING the same information over again?

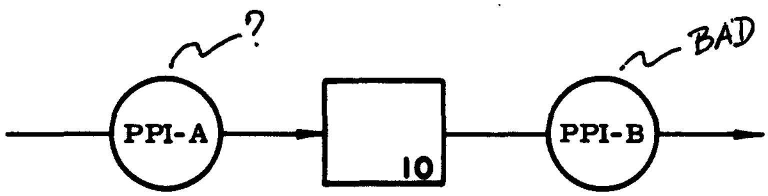
4. Suppose you GUESS that the malfunction is in Box X, but your CHECK tells you that the trouble is not in Box X. What would happen to your confidence in the GUESS?

Turn to Page 54 in the ANSWER book.

If the purpose of the CHECK step in the troubleshooting strategy is to get confidence in the GUESS so that you can save time in Phase II troubleshooting, then it is important that the CHECK step itself not require a great deal of time. It would be foolish to use a CHECK step that would take a lot of time during Phase I in order to save time during Phase II. Therefore, one criterion for a good CHECK step is that it be easy to perform.

Now that you know the purpose of the CHECK step is to gain confidence in your GUESS, you can see that sometimes you will not need to make a CHECK. Thus, you will not need to make a CHECK when your confidence in your GUESS is high without a CHECK. However, the CHECK step is called out as one of the steps in the troubleshooting strategy to remind you that you should always consider whether or not the CHECK step is necessary.

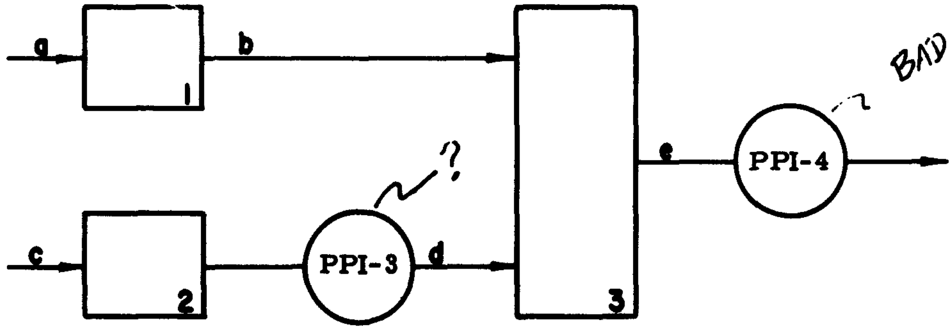
In general, when you can directly inspect all of the inputs to a box and all of the outputs from the box with read-outs that you are confident about, you will not actually need to make a CHECK. Thus if you have a situation like this:



where you can be confident about your interpretation of the indicators on the input and output side of the box, you do not need a CHECK. If you are confident of your interpretation of PPI-A and PPI-B, then in this case, you can be very confident that the trouble must be in Box 10. In Phase I troubleshooting of the T-2, there are very few cases like the one shown in the figure above, however. Therefore, for most of the guesses that you make about the locations of trouble in the T-2 during Phase I troubleshooting, you will need to perform a CHECK because many times you will not be confident in your GUESS without making a

CHECK. That is why you need to know how to carry out the CHECK step.

A CHECK is any easy-to-perform step that will independently test your GUESS. Thus, if you think the malfunction is in a particular box, you should ask yourself, "What can I do to the suspected bad box that will give me some new information about whether or not the malfunction is located within it?" For example, if you have guessed that the bad read-out at PPI-4 in the diagram below is caused by a malfunction in Box 1, a way that you could CHECK this GUESS would be to disconnect Box 1 (data line b) and then take another look at PPI-4. If the indication of the trouble on PPI-4 disappears when Box 1 is disconnected, then you will have some new information about your GUESS that will support your GUESS, and you should have high confidence that the malfunction is really in Box 1.

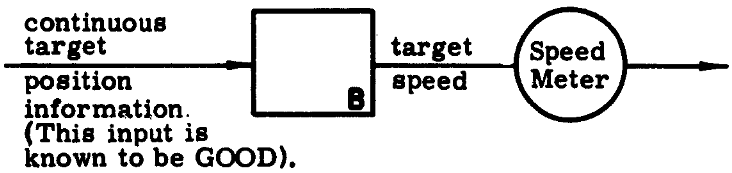


In the T-2, there is a special reason why you need to use a CHECK step in your Phase I troubleshooting strategy. The special reason is: when the T-2 is operating normally, it is processing raw video data making the interpretation of PPI read-outs difficult. It is difficult to

interpret a PPI reading with raw radar data coming into the T-2 because you cannot tell exactly what a PPI display should look like. When you look at a PPI display, there may be a minor deviation in the display which indicates a malfunction. But you may not be able to identify the bad feature by visual inspection simply because you have no "correct" display to compare with the "BAD" one. Therefore, you are likely to be misled in reading the PPI displays and you are likely to make incorrect GUESSES about the location of a malfunction. In a later lesson, you will learn to CHECK your GUESSES about the location of a malfunction during Phase I troubleshooting in the T-2. You will learn special signals which you inject into the system and which have known read-out characteristics on the PPIs. When you inject these special signals, you will know ahead of time precisely what a good PPI reading should look like and you can use the PPI read-outs with these special signals to CHECK your GUESSES. Thus, in carrying out Phase I troubleshooting on the T-2, you will base your GUESS about the location of a malfunction on read-out information that you obtain when the system is processing radar inputs. You will then CHECK those GUESSES by injecting special signals into the system to find out whether or not the read-outs will support or confirm your GUESS. If the GUESS you have made with normal radar inputs is confirmed by information that you obtain by injecting a special signal to CHECK the GUESS, then you will have high confidence that your GUESS has been correct, and you will be ready to go on to Phase II troubleshooting knowing that you will be working in the right functional area of the system.

So far in this lesson, you have learned that the reason for the CHECK step in the troubleshooting strategy is to give you confidence that your GUESS for Phase I, about the location of the malfunction, has been correct so that you will be unlikely to go on to Phase II and spend a lot of time looking in the wrong box. You have learned also that you must carry out a CHECK whenever you need to improve your confidence in a GUESS before you go on to Phase II troubleshooting. Finally, you have learned that any procedure which is easy-to-perform and which

will give you independent information about the location of a malfunction can be used for the purpose of making a CHECK. The principle way that you will carry out CHECKS for the AN/FST-2 will be to inject special signals into the system, which have known read-out characteristics that will enable you to obtain independent information about the location of a malfunction in the system.



Suppose you read the meter (indicator) in the system diagrammed above while the system is operating with a real target 100 miles away, and suppose you cannot detect anything wrong with the read-out. That is, suppose the meter changes from time to time in an apparently normal way, and that all of the speed readings it shows are reasonable ones.

(a) Can you be sure that there is no trouble in Box B?

Turn to Page 55 in the ANSWER book.

(b) Suppose you decide that the Speed Meter readings are just a little too high for a normal target and you, therefore, GUESS that there is a malfunction in Box B. Would you be confident that your GUESS is good?

______ high confidence   _____ low confidence

Turn to Page 55 in the ANSWER book.

(c) Would you need to CHECK your GUESS that Box B contains a malfunction?

_____Yes   _____No

Turn to Page 55 in the ANSWER book.

(d) Why is it difficult to tell from the Speed Meter whether or not the output of Box B is good?

Turn to Page 55 in the ANSWER book.

(e) How could you CHECK Box B?

Turn to Page 56 in the ANSWER book.

This is the last lesson in which you will learn general facts about Phase I troubleshooting. In the next lesson, LESSON 7, you will begin to learn about the specific steps that you must take to carry out Phase I troubleshooting of the Fine Grain Data Section. Therefore, the next exercise is designed to help you consolidate the GATHER, GUESS, and CHECK steps which you learned in the last three lessons.

Diagram 6-1 in the Diagram book is a Phase I troubleshooting diagram for an imaginary system. Because it is an imaginary system, the lines which connect the boxes have been labeled with letters rather then with words to describe the data that is flowing between boxes. However, you can pretend that it is a real system and carry out Phase I troubleshooting using this diagram. Turn to Diagram 6-1 in your diagram book now. Notice that the reading at each indicator is shown on the diagram. Pretend the readings shown are those which you have GATHERED by reading the indicators on the operating system. Use the diagram in answering the questions in the exercise which follows.

(a) Has all of the necessary information been GATHERED?

(b) What are your primary and secondary GUESSES about the location of the malfunction in this system? In making your GUESS, you should assume that you have high confidence in the read-outs at PPI-1, PPI-2, and PPI-3.

Turn to Page 57 in the ANSWER book.

(c) Suppose that it is relatively simple to disconnect data line h. Do you need to CHECK your GUESS? Give a reason for your answer.

(d) How could you CHECK your GUESS that the trouble is in Box 4?

(e) Suppose when you disconnect data line h that you no longer find a bad indication in the read-out at PPI-4. What would you do about your GUESS that the trouble is in Box 4?

Turn to Page 50 in the ANSWER book.

Use Diagram 6-2 in the Diagram book to answer the following:

(a) Suppose the read-out at PPI-1 in Diagram 6-2 is BAD. Would you need a CHECK to determine whether or not the trouble is really in Box 1?

(b) Suppose when you interpreted PPI-4, you were unable to find any bad indication, but the PPI-5 was clearly BAD and that you had an X alarm. What would you GUESS about the location of the malfunction?

(c) If your primary GUESS were Box 7 and your secondary GUESS Box 5, in the previous question, would you need to CHECK those GUESSES?

Turn to Page 59 in the ANSWER book.

(d) In the Diagram 6-2, assume that you have a ? PPI-6 read-out, and a BAD PPI-7 read-out, and that you have high confidence in both of these read-outs. Would you need to CHECK your GUESS that the malfunction is in Box 8?

(e) Suppose in the above question, in which PPI-6 appears to be OK and PPI-7 is clearly BAD, that you had very little confidence in your read-outs at PPI-6 and PPI-7. Would you need to CHECK your GUESS that the trouble is in Box 8?

Turn to Page [illegible] in the ANSWER book.

TEST F

Question 1

Turn to Diagram 6-3 in your DIAGRAM book. There are four different troubleshooting problems on Diagram 6-3, numbered 1, 2, 3, and 4 to correspond to the questions in this test. In each problem, the information that has been GATHERED is given on the diagram. Answer the questions in this test using diagram 1 for Question 1, and so on.

(a) What box is most likely to contain the malfunction?

Box ___________

(b) If you are highly confident that the read-out at PPI-6 means that the data inspected by PPI-6 are GOOD, would you need to CHECK your GUESS?

Turn to Page 61 in the ANSWER book.

TEST F

Question 2

(a) What box is most likely to contain the malfunction?

Box ________________

(b) Would you need to CHECK your GUESS?

Turn to Page 62 in the ANSWER book.

Question 3

(a) What box or boxes contain the malfunction?

(b) Would you need to CHECK your GUESS?

Turn to Page 63 in the ANSWER book.

Question 4

(a) What box or boxes contain the malfunction?

(b) Would you need to CHECK your GUESS?

Turn to Page 64 in the ANSWER book.

LESSON 7

In this lesson you will learn:

To solve simple Phase I troubleshooting problems in the Fine Grain Data Section of the AN/FST-2 by using a simplified troubleshooting diagram and the GATHER, GUESS, CHECK strategy.

LESSON 7

In the first six lessons you learned how to interpret a troubleshooting diagram of a system, and you learned some basic facts about the troubleshooting process. In this lesson, you will begin to learn to apply these facts to Phase I troubleshooting of the Fine Grain Data Section of the AN/FST-2.

> Turn to Diagram 7-1 in your Diagram book. Leave this diagram open so that you can refer to it from time to time as you read the material in this lesson.

This diagram is a simplified troubleshooting diagram of the Fine Grain Data Section. In the next lesson, more information will be added to this diagram, but for now this simplified diagram will be used. This diagram can be used to help you GUESS the location of a malfunction. The purpose of the following exercise is to familiarize you with this diagram.

Turn to Page 7-3 and do the exercise.

1. Locate the four video quantizing functions on the troubleshooting diagram, and write the numbers of the boxes in the space below.

2. In the space below, list the indicators which you can use to inspect the outputs of the four video quantizing functions.

3. (a) What indicator can be used to inspect the output of the Quantized Video Gating and Mapping function?

   (b) Does this indicator inspect all of the outputs of Box 5?

Turn to Page 85 in the ANSWER book.

4. In terms of boxes, what area of the system is checked by the V alarm on Diagram 7-1?

5. If you had a V alarm and if you knew for sure that there were no malfunctions within the area that you have just located, you might expect that the V alarm was caused by a bad <u>input</u> to that area. Where would you look to inspect the input to that area?

6. Why is a reading at PPI-d more comprehensive than a reading at the VM PPI or at PPI-S?

7. If you have an H alarm, would it be likely to be caused by a trouble in Box 12?

Turn to Page [illegible] in the ANSWER book.

8. List the numbers of the boxes which are in the area checked by the L alarm.

9. If you look across the top of the Diagram 7-1, you will find that there is a main line of data flow which starts with the raw video inputs through PPI-V, PPI-d, and the area checked by the L alarm. What is the first function in which this line of data joins the target range data which passes through Box 22?

10. Below the top line of data flow which was just described, there are three other main lines of data flow that enter the Message Formation function. Name the three alarms for these three lines of data flow.

Turn to Page (87) in the ANSWER book.

11. Will a malfunction in Box 17 give a bad read-out when you have set the RAPPI to read Phone Line 2?

12. (a) Where do you look in the troubleshooting diagram to find all of the inputs to the Fine Grain Data Section?

(b) How many of them are listed?

13. What indicator is used to read out the final output of the Fine Grain Data Section?

Turn to Page [illegible] in the ANSWER book.

As you carried out the exercise above, you should have noticed that the data flows from left to right across the diagram. You should also have noticed that all of the arrows in the diagram are labeled to tell what data passes from one function to another. Each of the boxes in the diagram is also named. Some of the names which are used for the boxes may not be familiar to you, but they have been carefully selected to describe the functions which are carried out by each of the boxes. The names are different from those you are familiar with because the boxes describe the Fine Grain Data Section in a way which differs from the block diagrams you have seen. The specific hardware components which carry out each function shown in the diagram could be listed, but you would not need the list of hardware until you go on to the next step in troubleshooting. Phase I will not take you further than the functional boxes shown in the diagram.

Like the troubleshooting diagrams which you saw in the first six lessons, this diagram contains two main elements; boxes which imply functions, and circles (or semi-circles) which imply read-outs.

The indicators (O's and ◠'s) which are shown in this diagram are all of those which you should use in Phase I troubleshooting. Ordinarily in Phase I troubleshooting you will never have to use any indicators other than those shown in the diagram.

The boxes in the diagram identify all of the possible answers to any Phase I troubleshooting problem. That is, at the end of Phase I troubleshooting you should always arrive at a conclusion which says that the trouble is in one of the boxes shown in the troubleshooting diagram. The diagram not only identifies the read-outs where you start Phase I troubleshooting; it also identifies the functions where Phase I troubleshooting will end.

Turn to the exercise on the next page, Page 7-8.

1. How do you use the ○'s and ⌓'s in the troubleshooting diagram when you are doing Phase I troubleshooting?

2. How do you use the ▭'s in the diagram when you are doing Phase I troubleshooting?

Turn to Page [illegible] in the ANSWER book.

When you carry out Phase I troubleshooting using this troubleshooting diagram you will use the GATHER, GUESS, CHECK strategy. This is the strategy which you were taught in the first part of this course. Now follow this example of how the strategy works when it is used to troubleshoot the Fine Grain Data Section.

1. GATHER ALL OF THE INFORMATION.

In order to carry out this step, you must inspect all of the read-outs shown on the troubleshooting diagram. Turn to Diagram 7-2 now. This diagram displays the actual read-outs you would obtain if there were a particular trouble in the Fine Grain Data Section. Fill in the blanks below with all of the information that you GATHER, using ?, GOOD, and BAD to record your readings.

PPI-1	?	ZV	GOOD
PPI-2		ZH	

Turn to Page 70 in the ANSWER book.

2. GUESS WHICH BOX CONTAINS THE MALFUNCTION

The best guess that you can make about the location of the malfunction is that Box 9 is functioning improperly. Thus, the bad read-outs at the RAPPI, at PPI-S, and at PPI-d indicate that the main line of data flow across the top of the diagram contains a malfunction. Working backward along that line of data flow, we find that the first BAD read-out is at PPI-D. PPI-V as well as VM PPI PPI-1, PPI-2, PPI-3 and PPI-X all appear to be good, although we cannot, of course, be certain of this. However, if we assume that PPI-V is good then the trouble must lie in one of the functions between PPI-V which is ? and PPI-d which is BAD. If the malfunction were in Box 7 or in Box 8 we should have a V alarm, but we do not. This leaves the Statistical Detection function of Box 9 as the most likely source of the malfunction.

3. CHECK YOUR GUESS.

For the present, you will not be taught how to CHECK your guesses; you will begin to learn about checking in LESSON 9.

As the example above shows, to GATHER the information for Phase I troubleshooting, you use the rules you learned in LESSON 4. You must GATHER information from all of the indicators shown on the Phase I troubleshooting diagram. Likewise, in order to GUESS about the location of a malfunction, you must use the rules you learned in LESSON 5. If you feel that you need to refresh your memory about how to GATHER or how to GUESS, go back and review these lessons now before you start Test G on the next page. If you think that you can use a diagram like Diagram 7-1 without review, go on to Test G without review.

TEST G

Question 1

Turn to Diagram 7-3.
What is the most likely location of the malfunction in the system described by this diagram?

The trouble is most likely in Box ______.

Turn to Page 71 in the ANSWER book and score your own answer.

TEST G

Question 2

Turn to Diagram 7-4.
What is the most likely location of the malfunction in the system described by this diagram?

The trouble is most likely in Box ________.

Turn to Page 72 in the ANSWER book and score your own answer.

TEST G

Question 3

Turn to Diagram 7-5.
What is your "first guess" about the location of the malfunction in the system described by this diagram?

First GUESS: ____________________

What is your "second guess"?

Second GUESS: ____________________

Turn to Page 73 in the ANSWER book and score your own answer.

TEST G

Question 4

There is a trouble in Box 21.

Indicate below the read-outs that you would expect to find at each of the listed built-in indicators if there were this trouble in the system. You may look at Diagram 7-1.

PPI-1	____________
PPI-2	____________
PPI-3	____________
PPI-X	____________
PPI-V	____________
PPI-d	____________
PPI-S	____________
RAPPI (both phone lines)	____________
ZV	____________
ZH	____________
ZL	____________
ZA	____________
ZF	____________
ZT	____________

Turn to Page 74 in the ANSWER book and score your own answer.

TEST G

Question 5

The combined RAPPI read-out is BAD.
When the RAPPI is placed on Phone Line 1, the read-out is BAD.
When the RAPPI is placed on Phone Line 2, the read-out appears to be OK as far as can be detected by visual inspection.
All the other read-outs appear OK.

Where is the malfunction?
(Use Diagram 7-1 for help).

Turn to Page 75 in the ANSWER book and score your own answer.

DO NOT TAKE THIS TEST UNLESS YOU WERE INSTRUCTED
TO DO SO ON PAGE 75 IN YOUR ANSWER BOOK

RE-TEST G

Question 1

Turn to Diagram 7-3.
What is the most likely location of the malfunction in the system described by this diagram?

The trouble is most likely in Box ________.

Turn to Page 71 in your ANSWER book and score your answer.

RE-TEST G

<u>Question 2</u>

Turn to Diagram 7-4.

What is the <u>most likely</u> location of the malfunction in the system described by this diagram?

The trouble is most likely in Box ________.

Turn to Page 72 in the ANSWER book and score your own answer.

RE-TEST G

Question 3

Turn to Diagram 7-5.
What is your "first guess" about the location of the malfunction in the system described by this diagram?

First GUESS: ____________________

What is your "second guess"?

Second GUESS: ____________________

Turn to Page 73 in the ANSWER book and score your own answer.

RE-TEST G

Question 4

There is a trouble in Box 21.

Indicate below the read-outs that you would expect to find at each of the listed built-in indicators if there were this trouble in the system. You may look at Diagram 7-1.

PPI-1	____________
PPI-2	____________
PPI-3	____________
PPI-X	____________
PPI-V	____________
PPI-d	____________
PPI-S	____________
RAPPI (both phone lines)	____________
ZV	____________
ZH	____________
ZL	____________
ZA	____________
ZF	____________
ZT	____________

Turn to Page 74 in the ANSWER book and score your own answer.

RE-TEST G

Question 5

The combined RAPPI read-out is BAD.
When the RAPPI is placed on Phone Line 1, the read-out is BAD.
When the RAPPI is placed on Phone Line 2, the read-out appears to be OK as far as can be detected by visual inspection.
All other read-outs appear OK.

Where is the malfunction?
(Use Diagram 7-1 for help).

Turn to Page 78 in the ANSWER book and score your own answer.

LESSON 8

In this lesson you will learn:

1. How to make a Phase I GUESS using a complete Phase I troubleshooting diagram.
2. What the T alarm is and how to use it.
3. What the following symbols on the GUESS diagram mean: red feedback lines, green arrows, and shaded boxes.

LESSON 8

In previous lessons you have learned to make guesses based on the in-line indicators such as the various PPI positions and the RAPPI, both alone and in combination with the Warning Lights. In the last lesson you were introduced to a simplified troubleshooting diagram of the Fine Grain Data Section of the AN/FST-2. Now you will learn to make Phase I GUESSES using a complete Phase I troubleshooting diagram.

> Now obtain a plastic covered GUESS job aid and a grease pencil from your Course Monitor.
>
> The diagram on this job aid is the complete troubleshooting diagram for the Fine Grain Data Section of the AN/FST-2. That is, it contains all of the functions (represented by boxes) and all of the read-outs (represented by circles and semi-circles) that you will need in order to accomplish Phase I troubleshooting. This is the diagram that you will be given to use as an aid on-the-job after you have finished this course. In this lesson you will learn how to utilize this complete troubleshooting diagram. Look at it briefly, then put it aside and go on reading the lesson.

There is one alarm on the Warning Light panel that we have not yet used and which is worthy of special consideration. This Warning Light

is the T alarm. This is a general purpose alarm which does not give you very precise information, but which you may find useful occasionally.

Look at Diagram 8-1 in your DIAGRAM book. You can see that the T alarm is associated with Box 27 which is really a check box as shown by the dotted outline. Box 27 is not in the main line of data flow.

In order to understand the T alarm and its check circuit, you must know about the One-Mile Test Target. The One-Mile Test Target is not a real target. Rather, it is a special piece of data which is artificially generated in Box 6. The data generated simulate a target at one mile with a known azimuth. The data are processed through the Fine Grain Data Section just like the normal target data which come out of Box 6. After being processed within the Fine Grain Data Section, the One-Mile Test Target is displayed on the RAPPI. You can easily identify the One-Mile Test Target presentation on the RAPPI because it is coded in the shape of a square. You can also use the printer to print out the range and azimuth of the One-Mile Test Target; and since the correct range and azimuth of this target are known, you can easily tell from your print-out whether or not the One-Mile Test Target is correct.

Turn to the next page and do the exercise.

Use Diagram 8-1 for the following exercise:

(a) Where is the One-Mile Test Target generated?

(b) What two data are used to generate the One-Mile Test Target?

(c) After the One-Mile Test Target data leaves Box 6, what boxes process the data before it appears on the RAPPI?

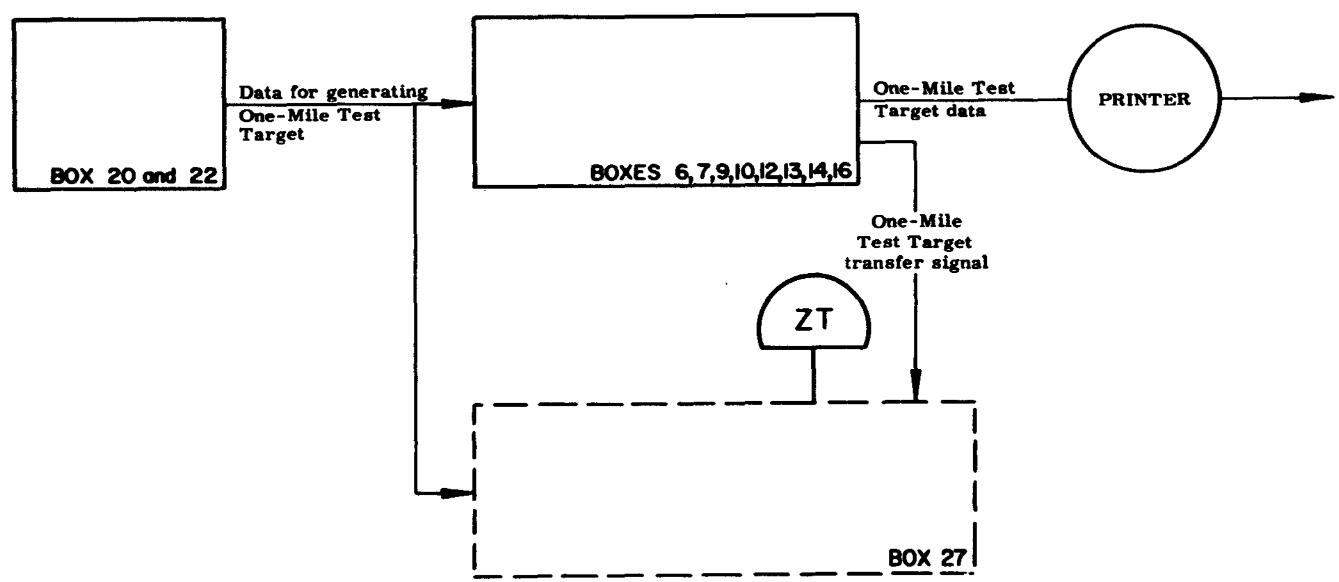
(d) There are two inputs to Box 27. Look at the names of the data which go to Box 27. Does Box 27 check normal target data or the One-Mile Test Target data?

Turn to Page 77 in the ANSWER book.

Box 27 is a check function. However, it does not check on the processing of normal target data; rather, it checks whether or not the One-Mile Test Target has been processed properly. The idea behind Box 27 is this: if there is a malfunction in one of the boxes through which the One-Mile Test Target is processed, then the malfunction will be likely to affect the One-Mile Test Target data, as well as normal target data. Therefore, if the One-Mile Test Target data comes out all right, you can expect that the normal target data is being processed correctly. However, you cannot be certain that there is no malfunction just because the One-Mile Test Target checks out all right at Box 27. One reason that you cannot rely on Box 27 as a complete check of the One-Mile Test Target is because Box 27 simply checks the time at which the One-Mile Test Target is transferred; it does not check whether or not the data are correct with respect to range and azimuth. You can, however, use the test target print-out to check the range and azimuth of the transferred test target data. Ordinarily, you should use the test target print-out in conjunction with the T alarm on Box 27. The diagram below shows how the data which generate the test target also go to Box 27, and how the test target data which is processed through Box 7, 9, 10, 12, 13, 14, and 16 cause a transfer signal to be sent to Box 27 so that the comparison can be made in Box 27.

Compare the figure on Page 8-6 with Diagram 8-1.

Turn to the next page and continue the lesson.


BOX 20 and 22
Data for generating
One-Mile Test
Target
BOXES 6,7,9,10,12,13,14,16
One-Mile Test
Target data
PRINTER
One-Mile
Test Target
transfer signal
ZT
BOX 27

The figure on Page 8-6 shows how you can use Box 27 as a check circuit. In using Box 27 as a check circuit, you should treat Boxes 6, 7, 9, 10, 12, 13, 14, and 16 as one function because when you get a T alarm, you cannot tell which of these boxes contains the malfunction which might have caused the alarm. You can also see in the figure on Page 8-6 that if you want to tell whether or not the failure is in Box 27 itself, you can use the test target print-out as an in-line indicator just like you use the PPIs as in-line indicators with other check circuits. If you have a T alarm but if the test target print-out is GOOD, then you know that you should GUESS Box 27 as the location of the malfunction.

To review:

1) A T alarm may be caused by a malfunction in one of the boxes which process the One-Mile Test Target data; that is, Boxes 6, 7, 9, 10, 12, 13, 14, or 16. Ordinarily, if the T alarm is caused by a malfunction in one of these boxes, you will also have a bad PPI reading somewhere -- or another alarm.

2) If you have a T alarm all by itself, then the trouble may be in one of the boxes which process the One-Mile Test Target data, or it may be that Box 27 itself is BAD. If you then take a test target print-out and find that it is GOOD, you should GUESS that the trouble is in Box 27 and not in one of the main line functions.

3) If you have both a T alarm and a bad test target print-out and if you can find no other indication of a malfunction, then you should suspect that the trouble is in the One-Mile Test Target generation function which is in Box 6, because a failure in this generation function could cause only the One-Mile Test Target to be bad; the normal target data would still be processed properly.

Turn to the next page and do the exercise.

The T alarm and Box 27 represent a typical check circuit arrangement. What is the proper in-line indicator to use when the only indication of a malfunction that you have is a T alarm?

Turn to Page 78 in the ANSWER book.

Suppose you have a T alarm, a BAD test target print-out, and a BAD RAPPI presentation. Considering <u>only</u> this information, what boxes might contain the malfunction?

Turn to Page 79 in the ANSWER book.

Suppose that you have both an H alarm and a T alarm and that the other indicators appear to be all right. Will the T alarm help you to locate the trouble?

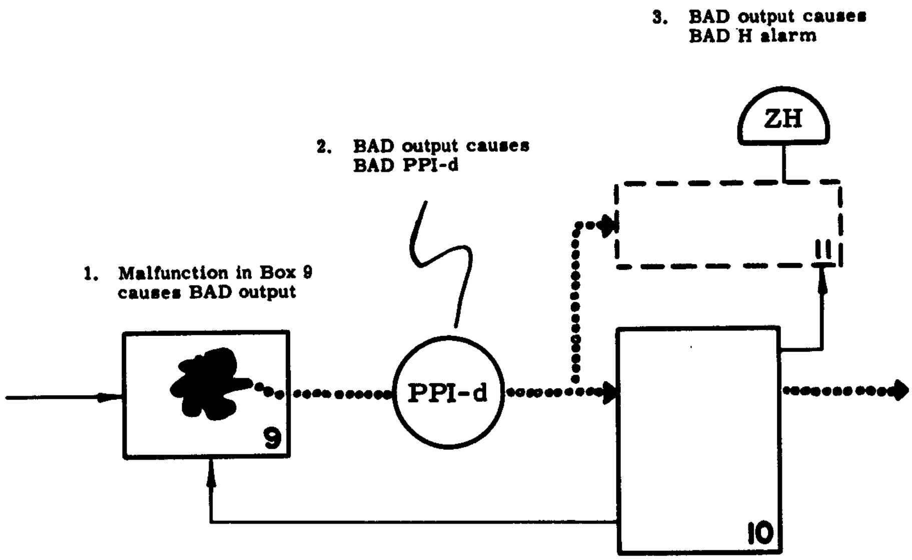
Turn to Page 80 in the ANSWER book.

Now we are going to introduce another new symbol, the symbol for feedback lines.

Turn to your GUESS job aid now. As you can see from this diagram, feedback lines are shown in red. Therefore, when you are making a guess as to the location of a malfunction, the red feedback lines should serve as a warning that the trouble may actually be due to a feedback signal.

Feedback lines make it more difficult to make a guess about the location of a malfunction. Consider, for example, the target status feedback line which goes from Box 10 to Box 9. Because of this

feedback line, the read-outs that you would GATHER if there were a trouble in Box 9 might be exactly the same as the read-outs for a trouble in Box 10. For example, if there is a malfunction in Box 9 (as shown in the figure below), it will cause a bad output which will cause: a BAD PPI-d, and an H alarm. The H alarm may be set off by the bad input to Boxes 10 and 11.



You might think that this pattern of read-outs could clearly tell you that the trouble is in Box 9 because you might think that a trouble in Box 10 could not cause a BAD PPI-d. However, because of the feed-back line from Box 10 to Box 9, a trouble in Box 10 could cause a BAD PPI-d. To see how this could happen, read the explanation on the next page.

Suppose that you have both an H alarm and a T alarm and that the other indicators appear to be all right. Will the T alarm help you to locate the trouble?

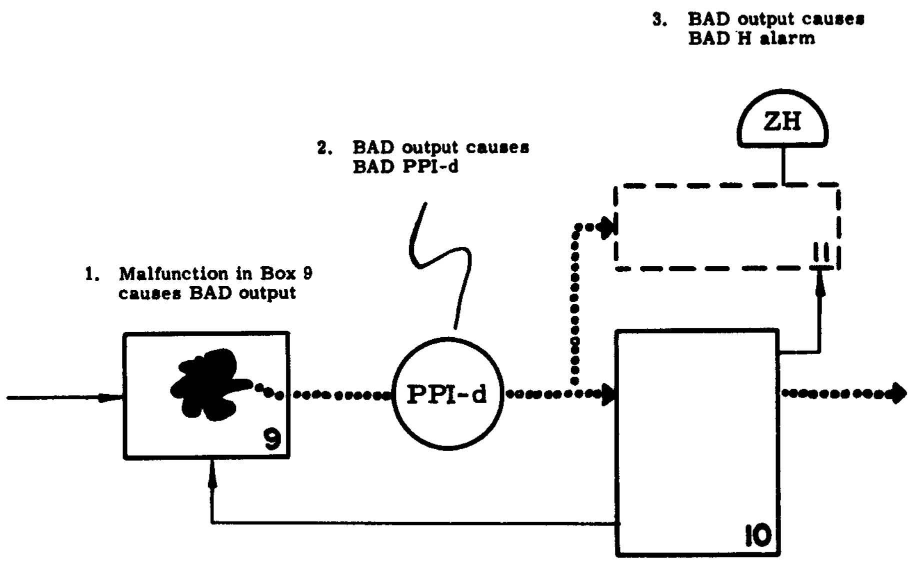
Turn to Page 80 in the ANSWER book.

Now we are going to introduce another new symbol, the symbol for feedback lines.

Turn to your GUESS job aid now. As you can see from this diagram, feedback lines are shown in red. Therefore, when you are making a guess as to the location of a malfunction, the red feedback lines should serve as a warning that the trouble may actually be due to a feedback signal.

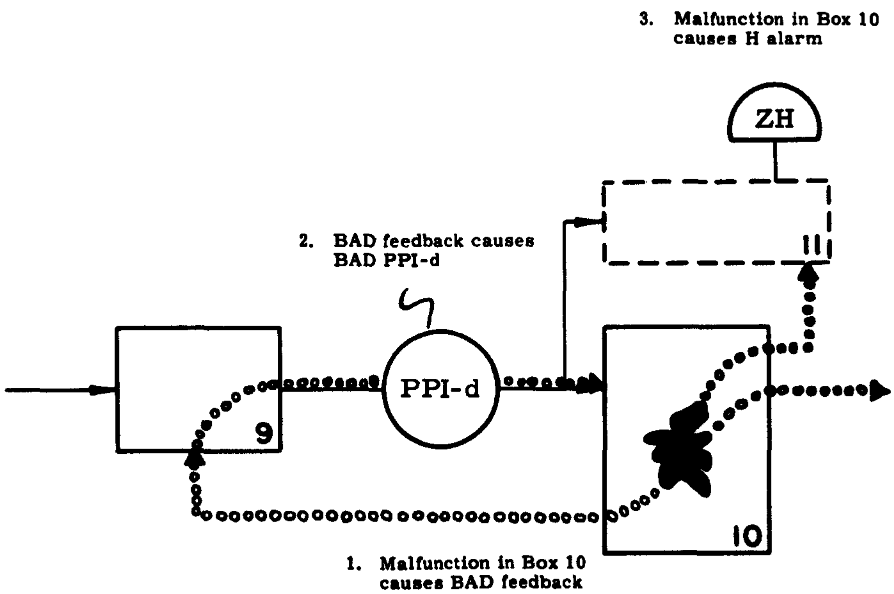
Feedback lines make it more difficult to make a guess about the location of a malfunction. Consider, for example, the target status feedback line which goes from Box 10 to Box 9. Because of this

feedback line, the read-outs that you would GATHER if there were a trouble in Box 9 might be exactly the same as the read-outs for a trouble in Box 10. For example, if there is a malfunction in Box 9 (as shown in the figure below), it will cause a bad output which will cause: a BAD PPI-d, and an H alarm. The H alarm may be set off by the bad input to Boxes 10 and 11.



You might think that this pattern of read-outs could clearly tell you that the trouble is in Box 9 because you might think that a trouble in Box 10 could not cause a BAD PPI-d. However, because of the feed-back line from Box 10 to Box 9, a trouble in Box 10 could cause a BAD PPI-d. To see how this could happen, read the explanation on the next page.

Let us suppose that Box 10 is BAD, as shown in the figure below. This would cause an H alarm and might also cause a bad feedback to occur in Box 9 by way of the red target status feedback line. This, in turn, would cause a BAD read-out at PPI-d. Thus, the over-all pattern of read-outs for a malfunction in Box 10 might be exactly the same as the pattern for a trouble in Box 9 due to the fact that there is a feedback line between Boxes 10 and 9. With a trouble in Box 10, the read-outs might be: a BAD PPI-d, and an H alarm.



Thus, you can see that when you are guessing you must take care to notice whether or not a feedback line is involved in the area of the malfunction. If there is a feedback problem you may have to make both a primary and a secondary GUESS about the location of the trouble. In the example we have just discussed, you might make Box 9 your "first GUESS" and Box 10 your "second GUESS."

The target transfer feedback line which goes from Box 16 to Box 10 can also cause difficulty when you are making a guess about the location of a malfunction that is in the general area of those two functions on your troubleshooting diagram. That is, a malfunction in Box 16 might feed back bad data to Box 10 and thus cause misleading read-outs at ZH, ZL, and PPI-S. The other feedback lines that might cause trouble are those which feed back a sample of all the shaped video inputs from Box 5 to Quantizers 1, 2, and 3.

Notice that the line labeled "One-Mile Test Target transfer signal" which goes from Box 16 to Box 27 is printed in black. This line is not a feedback line in spite of the fact that it runs opposite to the main line of data flow.

Describe how a malfunction in Box 10 could cause the same indications as a malfunction in Box 9.

The answer to this Exercise Question is given on Pages 8-10 and 8-11 in this TEXTBOOK.

Now look at the diagram on your GUESS job aid. There is a new box at the top of the diagram, Box 28, and a new set of symbols in this diagram, the green arrows at Boxes 7, 10, 13, 14, and 16. Notice that the green arrows which represent the inputs from the mechanical drum (Box 28) are drawn in a special way. They are drawn in this way merely to prevent confusion in the troubleshooting diagram. If the lines from the drum were drawn like the other lines they would be hard to follow. Notice also that the outputs from the drum system are divergent and concentrated in a relatively small area of the troubleshooting diagram.

Thus, you can see that a drum failure will probably cause only the following indications: ZV, ZH, ZL, PPI-d, PPI-S, and the RAPPI. If a malfunction occurs in the mechanical drum system it is apt to cause all of these indicators to be BAD. Therefore, whenever you have a V, H, and L alarm, or even just a V and L alarm occurring together, you should always expect that the malfunction is due to a bad input from the mechanical drum system and that the trouble might be located in Box 28. However, a malfunction in the mechanical drum system might <u>only</u> cause a V alarm. In this case it would appear the same as a trouble in the check circuit in the area checked by the V alarm, Box 8. Therefore, whenever a V alarm occurs in the absence of any other bad read-outs, you should always suspect a malfunction in the drum, Box 28, as your second GUESS. Box 8 would, of course, be your first GUESS.

Turn to the next page and do the exercise.

Study the diagram on your GUESS job aid and identify the main line functions that will be directly affected by a failure in the mechanical drum function. The box numbers of these main line functions are:

____

____

____

____

____

Turn to Page 81 in the ANSWER book.

1. If all of these functions are badly affected by a mechanical drum failure, what are the three alarms that you will obtain?

______

______

______

2. If a drum failure sets off the V, H, and L alarms, it may also cause a T alarm. What data flow line to Box 27 will carry the bad signal that will cause the T alarm? Give the label of this line:

______________________.

3. If a V alarm occurs in the absence of any other bad read-outs, what would be your primary and secondary GUESSES as to the location of the malfunction?

Turn to Page 82 in the ANSWER book.

Look at the diagram on your GUESS job aid again. Notice that we have introduced the last new symbol, shaded boxes, on this diagram.

The shaded boxes stand for the functions which provide inputs to the Fine Grain Data Section. That is, a shaded box stands for something which happened outside of the Fine Grain Data Section but which can cause a bad signal to be detected within the Fine Grain Data Section. You need to keep these functions in mind when you are troubleshooting because sometimes you must guess that the trouble may not be located in the T-2 at all, but in one of those functions outside of the T-2. For example, if you have an R alarm and a BAD RAPPI read-out, your primary GUESS should be that the trouble is in Box 22. Your secondary GUESS should be that it is in some functional area outside of the T-2 which provides the input to Box 22. You must make this secondary GUESS because there is no read-out which you can use to make sure that the R alarm is not caused by a bad input to Box 22. In this case you need not consider that the CD could be bad because if it were, you probably would have an A alarm as well as an R alarm since the CD input goes to Box 19 and then to Box 20.

It will also be useful in making GUESSES in regard to the area monitored by the A alarm to remember that a trouble in Box 19 will <u>always</u> cause an A alarm.

Turn to the next page and start Test H.

TEST H

Question 1

What GUESS or GUESSES would you make about the location of the malfunction if you had GATHERED the read-out information given below? Use your GUESS job aid for help.

PPI-1	?	ZV	BAD
PPI-2	?	ZH	BAD
PPI-3	?	ZL	GOOD
PPI-X	?	ZA	GOOD
VM PPI	?	ZR	GOOD
PPI-V	?	ZF	GOOD
PPI-d	BAD	ZT	GOOD
PPI-S	?		
RAPPI (1)	BAD		
RAPPI (2)	BAD		
RAPPI (both)	BAD		

Turn to Page [illegible] in the ANSWER book.

TEST H

Question 2

What GUESS or GUESSES would you make about the location of the malfunction if you had GATHERED the read-out information given below? Use your GUESS job aid for help.

PPI-1	?	ZV	GOOD
PPI-2	?	ZH	BAD
PPI-3	?	ZL	GOOD
PPI-X	?	ZA	GOOD
VM PPI	?	ZR	GOOD
PPI-V	?	ZF	GOOD
PPI-d	?	ZT	GOOD
PPI-S	?		
RAPPI (1)	BAD		
RAPPI (2)	BAD		
RAPPI (both)	BAD		

Turn to Page 84 in the ANSWER book.

TEST H

Question 3

What GUESS or GUESSES would you make about the location of the malfunction if you had GATHERED the read-out information given below? Use your GUESS job aid for help.

PPI-1	?	ZV	GOOD
PPI-2	?	ZH	GOOD
PPI-3	?	ZL	GOOD
PPI-X	BAD	ZA	GOOD
VM PPI	?	ZR	GOOD
PPI-V	?	ZF	GOOD
PPI-d	?	ZT	GOOD
PPI-S	?		
RAPPI (1)	?		
RAPPI (2)	?		
RAPPI (both)	?		

Turn to Page 85 in the ANSWER book.

TEST H

Question 4

What GUESS or GUESSES would you make about the location of the malfunction if you had GATHERED the read-out information given below? Use your GUESS job aid for help.

PPI-1	?	ZV	GOOD
PPI-2	?	ZH	GOOD
PPI-3	?	ZL	GOOD
PPI-X	?	ZA	GOOD
VM PPI	?	ZR	GOOD
PPI-V	?	ZF	GOOD
PPI-d	?	ZT	BAD
PPI-S	?		
RAPPI (1)	?		
RAPPI (2)	?		
RAPPI (both)	?		

One-Mile Test Target print-out: GOOD

Turn to Page 88 in the ANSWER book.

TEST H

Question 5

What GUESS or GUESSES would you make about the location of the malfunction if you had GATHERED the read-out information given below? Use your GUESS job aid for help.

PPI-1	?	ZV	BAD
PPI-2	?	ZH	GOOD
PPI-3	?	ZL	GOOD
PPI-X	?	ZA	GOOD
VM PPI	?	ZR	GOOD
PPI-V	?	ZF	GOOD
PPI-d	?	ZT	BAD
PPI-S	?		
RAPPI (1)	?		
RAPPI (2)	?		
RAPPI (both)	?		

Turn to Page 87 in the ANSWER book.

TEST H

Question 6

What GUESS or GUESSES would you make about the location of the malfunction if you had GATHERED the read-out information given below? Use your GUESS job aid for help.

PPI-1	?	ZV	GOOD
PPI-2	?	ZH	GOOD
PPI-3	?	ZL	GOOD
PPI-X	?	ZA	GOOD
VM PPI	?	ZR	BAD
PPI-V	?	ZF	GOOD
PPI-d	?	ZT	GOOD
PPI-S	?		
RAPPI (1)	?		
RAPPI (2)	?		
RAPPI (both)	?		

Turn to Page 88 in the ANSWER book.

LESSON 9

In this lesson you should learn:

To use the Wedge Check in Phase I troubleshooting.

Before you begin this lesson, ask the Course Monitor for these items:

-- Wedge Check job aid
-- Spiral Check job aid
-- grease pencil
-- jumper wire.

LESSON 9

In the first six lessons you were taught to use a troubleshooting strategy consisting of three steps: GATHER, GUESS, and CHECK. In the last two lessons you learned how to apply the first two steps of the strategy to the AN/FST-2. That is, you have learned to GATHER all of the information presented by the built-in indicators and to mark this information down on your troubleshooting diagram. You have learned to make a GUESS as to the function or box which contains a malfunction, and in some cases, to back up your primary GUESS with a secondary GUESS. In this lesson, you will learn more about the third step of the troubleshooting strategy: how to CHECK your GUESSES.

You must learn to CHECK your GUESSES because you must be highly confident at the end of Phase I troubleshooting that you have located the functional unit which actually contains the malfunction. This is important because you will start Phase II troubleshooting in that functional area. If you have been wrong about your Phase I GUESS, and if you then start Phase II troubleshooting by looking in the wrong functional area, you will waste a lot of troubleshooting time. The CHECK step in the troubleshooting strategy is used to increase your confidence that your GUESS is correct before you go on to Phase II troubleshooting.

There is another reason for making a CHECK at the end of Phase I troubleshooting. Sometimes you cannot make a single GUESS about the location of a malfunction by using combinations of built-in indicators. Sometimes, as you learned, you will have to make a "first GUESS" and a "second GUESS." When this happens, you need a CHECK procedure to find out if the first GUESS was correct. If your first GUESS turns out to be wrong, you will know that you must go on and CHECK the

second GUESS, in order to be confident that it is a good guess before going on to Phase II troubleshooting.

Why should you always make a CHECK at the end of Phase I troubleshooting, before going to Phase II?

Turn to Page [illegible] in the ANSWER book.

In this lesson you will learn about the Wedge Check. Later you will learn about another CHECK procedure.

So far in this course you have been making all the read-outs from the built-in indicators when normal radar inputs are being sent to the Fine Grain Data Section. However, it is difficult to read the various PPI displays and the RAPPI with normal radar inputs. This is because it is hard to tell a good PPI or RAPPI display from a bad one with normal radar inputs. When you use the Wedge Check you will not use normal radar inputs, but you will use instead a special <u>injected signal.</u>

In the Wedge Check, you will insert this signal and you will then use the PPI and RAPPI displays to read-out the data which result from the injected signal. Unlike normal radar data, however, the Wedge signal produces a very easily recognized GOOD pattern on the RAPPI and PPI-S if there is no malfunction in the area of the system you are checking. The Wedge Check is, therefore, a very useful CHECK because it is easy to tell whether or not the RAPPI and PPI-S read-outs are GOOD or BAD when the Wedge is inserted.

> The Wedge is a signal of known values which is inserted to CHECK the function of a small area of the Fine Grain Data Section. These known values give certain definite read-outs on the RAPPI and PPI-S if there is no malfunction in the area being CHECKED. If there is a malfunction, these read-outs will deviate from the normal in a way which will enable you to identify the particular function or box which contains the malfunction. What advantage does this afford over the random type read-outs such as you get with normal target data?

Turn to Page 90 in the ANSWER book.

Now look at your plastic covered GUESS job aid. On this job aid you should find a green line around Boxes 12, 13, 14, and 15. The Wedge Check is used to CHECK any GUESS that the malfunction in the system is in a box within this green line.

For example, suppose when you GATHER information you find the following pattern of read-outs:

PPI-1	?	ZV	GOOD
PPI-2	?	ZH	GOOD
PPI-3	?	ZL	BAD
PPI-X	?	ZA	GOOD
VM PPI	?	ZR	GOOD
PPI-V	?	ZF	GOOD
PPI-d	?	ZT	GOOD
PPI-S	?		
RAPPI-1	BAD		
RAPPI-2	BAD		
RAPPI (both)	BAD		

Take your plastic covered GUESS job aid and the grease pencil and mark the read-outs given above on the job aid in the appropriate ▭'s.

Then use the job aid to help you GUESS which box contains the malfunction.

Turn to Page 91 in the ANSWER book .

Now before you go on to Phase II troubleshooting, you want to be highly confident that your Phase I GUESS has been correct. What you must do is CHECK your first GUESS, Box 14, before you are through with Phase I troubleshooting. How can you CHECK your GUESS that the trouble is in Box 14?

> Look at your GUESS job aid. You will find that Box 14 is inside a green rectangle which encloses several boxes on the GUESS job aid. Whenever you GUESS that the trouble is in one of the boxes within the green line, you should use the Wedge Check to CHECK your GUESS.
>
> List below all of the boxes which you should CHECK by means of the Wedge Check.

Turn to Page 92 in the ANSWER book.

Since your primary GUESS was Box 14, you will have to use the Wedge Check to satisfy yourself as to whether or not Box 14 is a good guess. How do you carry out the Wedge Check? You should use the Wedge Check job aid to help you carry out the Wedge Check.

Turn to the next page and do the exercise.

Use the Wedge Check job aid to help you answer the questions below:

1. At the top of the Wedge job aid there is a diagram which describes the area of the Fine Grain Data Section which is checked by means of the Wedge Check. This diagram shows all of the boxes which are within the green line on the GUESS diagram. However, it is not exactly the same as the diagram on the GUESS job aid. On the Wedge job aid, Box 14 is broken down into three component functions: Boxes 14a, 14b, and 14c. Which of these three boxes are used to carry out the function which is shown as Box 14 on the GUESS job aid?

2. When should you use the Wedge Check?

3. Do you need any special equipment to insert the Wedge?

Turn to Page 83 in the ANSWER book.

4. After you have inserted the Wedge signal, what indicator should you look at first?

5. What is the most important thing to look for to determine whether or not you have a GOOD Wedge pattern on PPI-S?

6. Will the display on PPI-S look different for a system with SIF as compared with a system that does not have SIF?

Turn to Page 84 in the ANSWER book.

7. Before you look at the Wedge on the RAPPI what must you do?

8. What is the difference between a GOOD Wedge on the RAPPI for a system with SIF as compared to a system without SIF?

Turn to Page 85 in the ANSWER book.

Back on Page 9-6, we said that the best GUESS that you could make about the location of the malfunction in the problem we were considering was Box 14. We GUESSED Box 14 because we had an L alarm, an apparently good PPI-S, and a BAD RAPPI. Now suppose we want to CHECK that GUESS. The way to do it is to follow Instruction 1 near the bottom of the Wedge job aid. If your system does not have SIF, you should use the table at the left near the bottom of the job aid. If your system does have SIF, you should of course use the table at the right side of the job aid, near the bottom. Let us pretend that the system we are working with does <u>not</u> have SIF. What must be done to CHECK the GUESS that the trouble is in Box 14. First, the Wedge must be inserted according to the instructions given in Instruction B. Then we must look at the Wedge on PPI-S and decide whether it is either GOOD or BAD. Let us suppose that when we do this, PPI-S shows a GOOD Wedge. Next we must look at the Wedge on the RAPPI. Let us suppose that when we do this we obtain a display like that shown in note T at the bottom of the Wedge job aid. Now we can use the table to CHECK our GUESS. At the lefthand side of the table you will find listed the three pieces of information to make a CHECK using the Wedge signal.

1. What are these three pieces of information that you need to make a Wedge Check?

2. Where do you start looking in the table to make a Wedge Check?

Turn to Page 96 in the ANSWER book.

In this case we have GUESSED the trouble is in Box 14 and we must look across the top of the table to find Box 14 listed. Under Box 14 we find that we must have an L alarm and that the Wedge must be GOOD on PPI-S; but that the Wedge must be BAD on the RAPPI. That is just what we have found and so we can be quite certain that the trouble is really in Box 14. However, the Wedge pattern on the RAPPI was not just a garbled mess; rather, it was a special kind of pattern like that shown in picture T at the bottom of the Wedge job aid and according to the table, if the Wedge display is like the one shown in T, the trouble must be in Box 14b. Therefore, we have not only shown that the GUESS about Box 14 was good, but we have also narrowed down the trouble within Box 14 to Box 14b: L_0-L_{11} Transfer.

Now take these materials and go to your Course Monitor.

- This textbook
- The GUESS job aid
- The Wedge job aid
- The jumper wire for inserting the Wedge.

Tell your Course Monitor that you are ready to practice the Wedge Check. Then with the help of the Course Monitor carry out the exercises below.

Go on to the next exercise.

1. Insert the Wedge signal in the off-line channel of the AN/FST-2. Do this without guidance from the Course Monitor. Instead, use Instruction B on your Wedge job aid.

Look at the GOOD Wedge pattern on PPI-S and compare it with Instruction B. If the system has SIF, the GOOD Wedge pattern will look like that shown in note Y.

Go on to the next exercise.

2. Insert the Wedge signal according to Instruction C. Look at the GOOD Wedge pattern on the RAPPI and compare it with Instruction C on the Wedge job aid. If the system has SIF, the GOOD Wedge pattern will look like that shown in note Z.

Ask the Course Monitor to show you some BAD Wedge patterns. Look at them both on PPI-S and the RAPPI. Compare them with the GOOD Wedge patterns shown on the Wedge job aid.

Go on to the next exercise.

3. What is the major difference between the diagram at the top of the Wedge job aid (within the green line) and the area within the green line of the GUESS job aid?

If you are not sure of the answer to this question, ask the Course Monitor for help.

Go on to the next exercise.

Ask the Course Monitor to insert the Wedge exercise malfunction in the off-line channel of the AN/FST-2.

Use the GUESS job aid and the Wedge job aid to carry out the following exercises. These exercises will lead you through the GATHER, GUESS, and CHECK steps of a troubleshooting problem. Thus, you will do all of the Phase I troubleshooting steps to locate a simulated malfunction in the off-line channel of the T-2.

Go on to the next exercise after the Course Monitor announces that he has inserted the simulated malfunction.

Turn to the exercise on the next page.

1. GATHER - After your Course Monitor has inserted the problem, GATHER all of the information which is easy to collect and place it in the appropriate ▭'s on your GUESS job aid with your grease pencil.

Go on to the next exercise after you have GATHERED all of the information.

2. GUESS - After you have GATHERED all of the information which is easy to collect, place your GUESS job aid on some convenient stand or table.

Write a 1 over the box which represents your first GUESS and a 2 over the box which represents your second GUESS as to the location of the malfunction. It is important that you use only the information on your GUESS job aid to make these GUESSES. Do not attempt to make your GUESSES from the actual built-in indicators on the machine as this will only tend to confuse you. Once you have GATHERED the information which is easy to collect, walk away from the machine and use only your GUESS job aid to make your GUESSES.

After you have made your GUESSES, turn to the next page to find out if you have reasoned correctly.

FIRST GUESS

Your first GUESS should have been that the trouble is in Box 15. The reason is that the L alarm tells you that the trouble is probably in the area checked by the L alarm or Boxes 13, 14, and 15. The apparently good PPI-S and RAPPI read-outs tell you that the trouble is most likely in the check circuit, Box 15.

SECOND GUESS

Your second GUESS might be Box 14, the main line function associated with the L alarm. Another possible second GUESS is Box 13.

Now that you have finished both the GATHER and the GUESS steps, you must go on and CHECK the first GUESS.

If your GUESS is wrong, however, find out why by consulting with your Course Monitor before going on.

The Wedge Check provides a way to CHECK these GUESSES. Notice that Box 15, your first GUESS, is located in the area outlined in green on your GUESS job aid. This tells you that you can CHECK this GUESS by using the Wedge Check as pointed out in Instruction A on your Wedge job aid. In this case, two of the possible second GUESSES, Box 14 and Box 13, are also contained in the area outlined in green on your GUESS job aid so that the Wedge Check can be used to CHECK both of your GUESSES.

The rest of the exercises which follow <u>all</u> have to do with CHECKING your GUESSES.

Insert the Wedge signal according to Instruction B on your Wedge job aid. Decide whether the Wedge is GOOD or BAD on PPI-S.

Then insert the Wedge according to Instruction C and determine whether the Wedge is GOOD or BAD on the RAPPI.

After you have done this exercise, turn the page.

You should have seen a GOOD Wedge both on PPI-S and on the RAPPI. (If you did not decide that the Wedge pattern was GOOD, repeat this step). Now follow the reasoning in the next exercise using your job aids.

Return the equipment to normal according to Instruction D on your Wedge job aid. Then place your Wedge Check job aid on some convenient stand or table and look at Instruction 1 at the bottom of the job aid. Follow Instruction 1 and decide whether or not your GUESS has been CHECKED. The CHECK confirms that the trouble is in Box 15: __________ Yes __________ No

According to Instruction 1, if you GUESS that the trouble is in Box 15, you should look down the column under Box 15. If the entries in that column agree with what you found while GATHERING the data generated by both the normal target data and the Wedge signal, you have CHECKED your GUESS.

If you look at your notes on your GUESS job aid, you will see that you had an L alarm with normal target data, so your findings check with the first cell under Box 15.

You also observed a GOOD Wedge on the PPI-S and RAPPI when the Wedge was inserted. This agrees with the information in the last two cells under Box 15.

Thus, you have CHECKED your GUESS that the trouble is in Box 15.

If your first GUESS had not checked out, you should go on to CHECK your second GUESS, which in this case might be Box 14. Since Box 14 is broken into three boxes, 14a, 14b, and 14c on your Wedge job aid,

you should compare the information you have already GATHERED with that contained in the cells under the column headed "Box 14a or Box 14b," "Box 14b only," and "Box 14c only," until you find one which agrees with the read-outs you obtained with normal target data and the Wedge signal. The one which agrees will contain the malfunction and you will have CHECKED your second GUESS. Notice that you can never be sure that a trouble is in Box 14a only.

If you had not been able to find a column which agreed with the data you GATHERED, then you should have gone back to the GATHER step and re-gathered the normal traget data read-outs and made two new GUESSES. Remember to consider the green arrows which represent inputs from the mechanical drum system and the red feedback lines when making your GUESSES.

> Remind your Course Monitor to remove the malfunction from the off-line channel, return to your study area and continue reading starting on the next page. If you have any questions about the Wedge Check, ask your Course Monitor for help now.

Pretend that there is a malfunction in Box 15. Indicate below the read-outs that you would expect to find at each of the listed built-in indicators. Remember that in the example in Lesson 9, Page 9-14, there was a trouble in Box 15.

With normal target inputs:

PPI-1	________
PPI-2	________
PPI-3	________
PPI-X	________
PPI-V	________
PPI-d	________
PPI-S	________
RAPPI (both phone lines)	________
ZV	________
ZH	________
ZL	________
ZA	________
ZR	________
ZF	________
ZT	________

With the Wedge inserted:

PPI-S ________ (GOOD or BAD)

RAPPI ________ (GOOD or BAD)

Describe a GOOD Wedge on the RAPPI: ___

____

Turn to Page 97 in the ANSWER book.

TEST I

Question 1

(a) When should you use the Wedge Check?

(b) What is the purpose of the Wedge Check?

Turn to Page 98 in the ANSWER book and score your own answers.

TEST I

Question 2

You have GATHERED the following information:

PPI-1	?	ZV	GOOD
PPI-2	?	ZH	GOOD
PPI-3	?	ZL	GOOD
PPI-X	?	ZA	GOOD
VM PPI	?	ZR	GOOD
PPI-V	?	ZF	GOOD
PPI-d	?	ZT	BAD
PPI-S	BAD		
RAPPI (combined)	BAD		
RAPPI (line 1)	BAD		
RAPPI (line 2)	BAD		
Test Target Print	BAD		

(a) Use your GUESS job aid and GUESS which box most likely contains the trouble.

(b) How would you CHECK that GUESS?

Turn to Page [illegible] in the ANSWER book and score your own answers.

TEST I

Question 3

Suppose that you use the Wedge Check to CHECK the GUESS (Box 12) that you made in the previous problem, and suppose that the Wedge looked like this:

PPI-S	GOOD Wedge
RAPPI	GOOD Wedge

What would these Wedge read-outs prove? (Use your job aid for help).

Turn to Page 100 in the ANSWER book and score your own answer.

LESSON 10

In this lesson you should learn:

To use the Spiral Check in Phase I troubleshooting.

LESSON 10

In this lesson, you will learn about another inserted signal which you can use to CHECK your GUESSES. This CHECK covers an area of the Fine Grain Data Section which is larger than the area covered by the Wedge Check. This CHECK is used when you have made a GUESS that the trouble is contained within the area outlined in orange on your troubleshooting diagram. It is called the "Spiral Check" and complete instructions on how to use it are contained on the Spiral Check job aid which you will be allowed to use on the job.

You may already be familiar with the Spiral Check, but you have probably not used it for troubleshooting purposes in the same way that you will be taught to use it in this lesson. You should always use it according to the instructions on your Spiral Check job aid if you are employing the Spiral Check for Phase I troubleshooting purposes.

> Now, look at the diagram at the top of your Spiral Check job aid.

Notice that the Spiral Check enables you to CHECK a GUESS that a malfunction is located in one of the boxes within the orange line on your troubleshooting diagram. Notice also that the diagram on the Spiral Check job aid breaks up Box 16 into Boxes 16a, 16b, and 16c. This means that if you GUESS that a malfunction is in Box 16, the Spiral Check will enable you to break the function represented by Box 16 on your troubleshooting diagram into three separate functions and will tell you which one of these functions contains the malfunction. Thus, the Spiral Check enables you to know, in even more precise terms, where

to begin Phase II troubleshooting. The Spiral Check, like the Wedge Check, is based on inserting a signal with known read-out characteristics into the Fine Grain Data Section of the AN/FST-2.

Use your GUESS job aid to answer these questions:

1. Would you use the Spiral Check to CHECK a GUESS that there is a malfunction in Box 9?

2. Would you use the Spiral Check to CHECK a GUESS about Box 6?

3. Would you use the Spiral to CHECK a GUESS about Box 23?

4. Would you use the Spiral to CHECK a GUESS about Box 13?

Turn to the next page and complete this exercise.

5. Would you use the Spiral Check to CHECK a GUESS about a trouble in Box 16b?

Turn to Page 101 in the ANSWER book.

A Spiral Check pattern is displayed on the RAPPI. The Spiral Check signal is a series of targets generated in successive half mile increments from range count of 1.5 miles and center azimuth count 65. It is continuous in azimuth increments of 10 and range increments of 0.5 miles until azimuth count 4095. When azimuth count 4095 is reached, the insertion stops until azimuth count 50 occurs, at which time the target spiral is again started at range count 1.5 miles. This results in a repetitive spiral of targets which are displayed on the RAPPI. If there is no malfunction in the portion of the Fine Grain Data Section which is checked by the Spiral Check, the pattern will appear as a perfect spiral such as the one shown in Instruction B near the middle of the Spiral Check job aid.

To use the Spiral Check, you must go through a procedure which is similar to the procedure for using the Wedge. The steps in using the Spiral are:

(1) Be sure that your GUESS is one of the boxes that can be checked by the Spiral. That is, be sure that the box is within the area outlined in orange on your GUESS job aid.

(2) Be sure that the channel you are checking is not "on-the-air".

(3) Insert the Spiral signal.

(4) Read out the indications you obtain when the Spiral is being processed by the Fine Grain Data Section and make the necessary print-outs.

(5) Look at the table in the Spiral Check job aid to see if the pattern of indications you obtain is the pattern you should obtain to CHECK your GUESS.

If you obtain the pattern of indications you should expect to obtain (as indicated in the table), then your GUESS will be CHECKED, and you will be ready to go on to Phase II troubleshooting. If the pattern of indications you obtain does not prove your GUESS to be correct, then you must proceed to CHECK your second GUESS.

Now, in order to familiarize you with the Spiral Check job aid, do the following exercise, using the plastic covered Spiral job aid:

Use Instructions A and B on the Spiral job aid to answer the following questions:

(1) When should you use the Spiral Check?

(2) When is S1969 returned to the "Normal" position?

Turn to the next page and continue the exercise.

(3) Can you read the Spiral on the RAPPI immediately after it is inserted?

(4) How do the following alarms (Warning Lights) behave when the Spiral is inserted?

ZH ______________

ZA ______________

ZL ______________

ZT ______________

Turn to Page 102 in the ANSWER book.

Now take these materials and go to your Course Monitor.

- This textbook
- The GUESS job aid
- The Wedge job aid and jumper wire
- The Spiral job aid

Tell your Course Monitor that you are ready to practice the Spiral Check. Then with the help of the Course Monitor, carry out the exercises which follow.

Go on to the next exercise on Page 10-7.

1. Insert the Spiral signal in the off-line channel of the AN/FST-2. Do this without guidance from the Course Monitor. Instead, use Instruction B on your Spiral job aid. After you have inserted the Spiral, go to the RAPPI and make sure that you have done it correctly.

   If you have inserted the Spiral correctly, you should be able to make the four print-outs given in Instruction B. Make these four print-outs.

   If you have any trouble with this exercise ask your Course Monitor for help.

Go on to the next exercise.

2. Ask your Course Monitor to simulate malfunctions that will cause Spiral patterns like pictures W and X at the bottom of the Spiral job aid. Observe these patterns on the RAPPI and compare them with notes W and X. Ask your Course Monitor for help if you are not able to match the Spiral patterns on the RAPPI with the pictures.

Go on to the next exercise.

Ask the Course Monitor to insert the Spiral exercise malfunction in the off-line channel of the AN/FST-2.

Use the GUESS job aid and the Spiral job aid to carry out the following exercises. These exercises will lead you through the GATHER, GUESS, and CHECK steps of a troubleshooting problem. Thus, you will do all of the Phase I troubleshooting steps to locate a simulated malfunction in the off-line channel of the T-2.

Go on to the next exercise after the Course Monitor announces that he has inserted the simulated malfunction.

1. GATHER - After your Course Monitor has inserted the problem, GATHER all of the information which is easy to collect and place it in the appropriate ▭'s on your GUESS job aid, with your grease pencil.

Go on to the next exercise after you have GATHERED all of the information.

2. GUESS - After you have GATHERED all of the information which is easy to collect, place your troubleshooting diagram on some convenient stand or table.

Write a 1 over the box which represents your first GUESS and a 2 over the box which represents your second GUESS as to the location of the malfunction. It is important that you use only the information on your GUESS job aid to make these GUESSES. Do not attempt to make your GUESSES from the actual built-in indicators on the machine, as this will only tend to confuse you. Once you have GATHERED the information which is easy to collect, <u>walk away from the machine</u>, and use only your GUESS job aid to make your GUESSES.

After you have made your GUESSES, turn to the next page to find out if you have reasoned correctly.

FIRST GUESS

Your first GUESS should have been that the trouble is in Box 21. The reason is that the A alarm tells you that the trouble is probably in the area checked by the A alarm, Box 20 and Box 21. The apparently good RAPPI, PPI-V, PPI-D and PPI-S read-outs tell you that the main line of data flow is probably good. Therefore the trouble is most likely in the check circuit in the A alarm area -- Box 21.

SECOND GUESS

Your second GUESS could be that the trouble is either in Box 20 or Box 19, or that it is due to one of the unchecked inputs to Box 20, the North reference pulse or the azimuth pulse. Remember that a trouble in Box 19 will always cause an A alarm. You would not be likely to GUESS that the clock pulse (CD) is BAD because that would cause an error in the Range Counter function (Box 22).

Now that you have finished both the GATHER and the GUESS steps, you must go on and CHECK the first GUESS.

> If your GUESS was wrong, however, find out why by consulting with your Course Monitor before you go on.

Since Box 21, your first GUESS, is located in the area outlined in orange on the troubleshooting diagram, you can use the Spiral Check to CHECK your GUESS. Notice that Boxes 20 and 19 are also located in the area outlined in orange. Thus, should your first GUESS prove incorrect, you can also CHECK at least part of your second GUESS with the Spiral Check. However, you cannot use the Spiral Check to CHECK the two system inputs because they are not included in the area outlined in orange.

The rest of the exercises in this lesson have to do with the use of the Spiral to CHECK the GUESS you have just made.

Insert the Spiral signal according to the instructions shown on your Spiral Check job aid and observe the Spiral pattern which appears on the RAPPI. Keep your Spiral Check job aid with you at the RAPPI. Decide whether or not the Spiral looks GOOD <u>by eye</u>. If you decide that it is not a GOOD Spiral, remember what it looks like.

Turn to the next page when you have finished this exercise.

You should have observed what appeared to be a GOOD Spiral by eye.

Now follow Instruction 1 above the table on your Spiral job aid. Use the following explanation for aid.

Since your GUESS was Box 21, you should enter the table on the Spiral job aid by looking at the column labeled "Box 21". If you read down this column, you will find all of the conditions that will prove a Box 21 GUESS to be correct. These conditions are:

1. With the RAPPI on both phone lines, the Spiral by eye appears to be: GOOD Spiral.
2. These print-outs will prove that the Spiral is really good:

2035	400	2585	510
2045	402	2595	512

3. ALARM (with normal data before inserting the Spiral): ZA only.

Go on to the next exercise.

You have already observed a GOOD Spiral by eye and obtained the necessary print-outs to prove that it is a GOOD Spiral, so you have met the first condition necessary to CHECK your Box 21 GUESS.

You have also observed an A alarm with normal target data, so you have also met the second CHECK condition. (You will not get an A alarm with the Spiral, however, because the A alarm is de-activated when you insert the Spiral).

However, you can still not be sure that Box 21 contains the malfunction. Notice that the last condition under the column labeled "Box 21" says that an alternate GUESS is Box 19. If you look at the left hand column under the heading "Box 19" on your table, you will see that the conditions are the same as those under Box 21. This means that you have an alternate GUESS for starting Phase II troubleshooting. Thus, if you are unable to locate the trouble in Box 21 when you start probing with the oscilloscope, you should look in Box 19.

If your GUESS in regard to Box 21 does not CHECK, you would have to return Switch S1969 to the "N" position and re-evaluate your GUESS, based on the normal radar inputs before deciding to start Phase II troubleshooting on the hardware which defines the system inputs. Remember the North reference pulse and the azimuth pulse constituted the last part of your second GUESS, but these could not be CHECKED by the Spiral Check. Also remember to consider the green arrows which represent inputs from the mechanical drum system and the red feedback lines when making your GUESSES.

> Remember to return Switch S1969 to the "N" position when you have completed the Spiral Check.
>
> Ask the Course Monitor for help in using the Spiral Check. if you need it.

Remind your Course Monitor to remove the malfunction from the off-line channel. Then, return to your study area and continue reading, starting with the next paragraph.

You should note the following things in regard to the use of the Spiral Check:

1. You should only use the Spiral Check when you GUESS that a trouble is in one of the boxes in the area outlined in orange on your troubleshooting diagram.

2. When a Spiral signal is inserted, the ZA alarm is de-activated but the Azimuth Counter itself is not de-activated. Also a ZT alarm will occur, but you can ignore the ZT alarm in this case.

Turn to the next page and do the exercise.

Use the plastic covered Spiral job aid for the following exercise:

1. Do you need a jumper wire to insert the Spiral signal?

2. If the Spiral obviously looks BAD, by eye, should you interpret it as ? or as BAD?

3. In order to prove that a Spiral pattern on the RAPPI is GOOD, how do you do it?

4. Describe the two indications you need to prove that there is a trouble in Box 16a, and tell what GUESS you would have made that would lead you to use the Spiral Check in this case.

Turn to Page 103 in the ANSWER book.

TEST J

<u>Question 1</u>

Record the following read-outs on your GUESS job aid and write your primary GUESS, as to the box containing the malfunction, in the space provided below. Also record your secondary GUESS or GUESSES, if you feel they are necessary. Describe how you arrived at your GUESSES.

PPI-1	?	ZV	GOOD
PPI-2	?	ZH	GOOD
PPI-3	?	ZL	GOOD
PPI-X	?	ZA	GOOD
VM PPI	?	ZR	GOOD
PPI-V	?	ZF	GOOD
PPI-d	?	ZT	BAD
PPI-S	?		
RAPPI (1)	BAD		
RAPPI (2)	BAD		
RAPPI (both)	BAD		

One-Mile Test Target print-out: BAD

Turn to Page 104 in your ANSWER book and score your own answer.

TEST J

Question 2

What CHECK would you use to CHECK your primary GUESS in the previous question? Why would you use this CHECK?

Turn to Page [illegible] in your ANSWER book and score your own answer.

TEST J

Question 3

Assume that you have inserted the Spiral signal according to Instruction B on your Spiral Check job aid. How would you enter the table on your Spiral Check job aid to CHECK your primary GUESS that the trouble is in Box 16? (Use your Spiral Check job aid to answer this question).

Turn to Page [illegible] in your ANSWER book and score your own answer.

TEST J

Question 4

Now assume that after you inserted the Spiral signal you obtained a Spiral pattern on the RAPPI similar to that shown in note W at the bottom of your Spiral Check job aid. Remember that you had a ZT alarm with the normal target data. Which of the three boxes listed under Box 16 would contain the malfunction?

Turn to Page 107 in your ANSWER book and score your own answer.

TEST J

Question 5

Record the following read-outs on your GUESS job aid and write your primary GUESS as to the box containing the malfunction in the space provided below. Also record your secondary GUESS or GUESSES, if you feel they are necessary. Describe how you arrived at your GUESSES.

PPI-1	?	ZV	GOOD
PPI-2	?	ZH	GOOD
PPI-3	?	ZL	GOOD
PPI-X	?	ZA	GOOD
VM PPI	?	ZR	GOOD
PPI-V	?	ZF	GOOD
PPI-d	?	ZT	GOOD
PPI-S	BAD		
RAPPI (1)	BAD		
RAPPI (2)	BAD		
RAPPI (both)	BAD		

One-Mile Test Target print-out: BAD

Turn to Page 108 in your ANSWER book and score your own answer.

TEST J

Question 6

What CHECK would you use to CHECK your primary GUESS in the previous question? Why would you use this CHECK?

Turn to Page 100 in your ANSWER book and score your own answer.

TEST J

<u>Question 7</u>

What combination of read-outs would you need before and after the Wedge signal was inserted to prove your primary GUESS that the trouble was in Box 12? (Use your Wedge Check job aid to answer this question).

Turn to Page 110 in your ANSWER book and score your own answer.

TEST J

Question 8

In Question 5, your second GUESS was that the trouble was in Box 9. What CHECK would you use to prove this GUESS?

Turn to Page 111 in your ANSWER book and score your own answer.